



A narrative review about difficult laparoscopic cholecystectomy: technical tips

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Background: Laparoscopic cholecystectomy (LC) is the most practiced procedure in general surgery worldwide. It is nowadays the optimum surgical procedure for symptomatic gallbladder lithiasis. Nevertheless, it should not be underestimated since vascular and biliary duct injuries are not uncommon, with devastating consequences. This study aimed to advise the best surgical technical approach for LC according to the intraoperative situation to avoid accidental anatomical structures injuries.

Methods: A traditional narrative literature search for articles published up to December 2021 was performed using the most common search engines (PubMed, Web of Science, Google Scholar). The search strategy utilized in all databases included the combination of the keywords: “laparoscopic cholecystectomy”, “difficult cholecystectomy”, “acute cholecystitis”, “prevention bile duct injuries”, “safe cholecystectomy”. No restrictions were applied to the language of the publication if an English version of the article was available.

Key Content and Findings: Difficult laparoscopic cholecystectomy (DLC) is a distressing condition. Its definition is not well established and may vary according to the surgeon’s experience. Several techniques have been proposed to minimize the bile duct or hepatic injury risk during the challenging cholecystectomy.

Conclusions: Although LC is nowadays the optimum surgical procedure for symptomatic gallbladder lithiasis, it should not be underestimated since vascular and biliary duct injuries are very morbid, significantly increase care costs, and often lead to litigations.

Keywords: Laparoscopic cholecystectomy (LC); challenging cholecystectomy; acute cholecystitis; prevention bile duct injuries (prevention BDI); safe cholecystectomy

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Introduction

Cholecystectomy is the most practiced procedure in general surgery around the world. Since laparoscopic cholecystectomy (LC) was first described in 1985, laparoscopic technology and technique development have revolutionized surgery (1).

LC has been a significant step forward if we think of the wide range of complications (cardiac, wound,

pulmonary complications, pain, late resumption of daily activities) linked to open cholecystectomy (2,3). Most patients undergoing LC have a rapid and complication-free hospitalization, with a postoperative course characterized by a rapid return to normal daily activities.

The incidence of bile duct injuries following LC has been reduced (0.32–0.52%) although it is even higher than open

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Table 1 The search strategy summary

Items	Specification
Date of search	15 December 2021
Databases and other sources searched	PubMed, Web of Science, Scopus
Search terms used	Laparoscopic cholecystectomy, difficult cholecystectomy, acute cholecystitis, prevention bile duct injuries, safe cholecystectomy, bailout procedure
Timeframe	Up to December 2021

cholecystectomy (0.1–0.2%) (4–6). In addition, no substantial change in morbidity or mortality was observed after LC (6).

Nowadays, it has been proven that the misconstruction of biliary anatomy is responsible for 71–97% of bile duct injuries (BDI) cases (7), so it is clear how safe dissection is the most crucial component of successful LC.

This study aimed to advise the best surgical technical approach for LC according to the intraoperative situation to avoid accidental anatomical structures injuries. We present the following article in accordance with the Narrative Review reporting checklist (available at <https://ls.amegroups.com/article/view/10.21037/ls-22-16/rc>).

Methods

A traditional narrative literature search for articles published up to December 2021 was performed using the most common search engines (PubMed, Web of Science, Scopus). The search strategy (*Table 1*) utilized in all databases included the combination of the keywords: “laparoscopic cholecystectomy”, “difficult cholecystectomy”, “acute cholecystitis”, “prevention bile duct injuries”, “safe cholecystectomy”, “bailout procedure”. We have also entered the search words in a different order to increase the availability of articles. We also screened the bibliography of all selected articles to identify others potentially eligible. No restrictions were applied to the language of the publication if an English version of the article was available.

Discussion

LC could be seen as a routine intervention, which some complications can burden with potentially dramatic implications. Therefore, it is mandatory to keep in mind some recommendations useful to choose the right approach during a cholecystectomy, especially when it is difficult.

There are several aspects that must be taken into account

in order to perform a safe LC and we will try to summarize below.

Anatomical landmarks

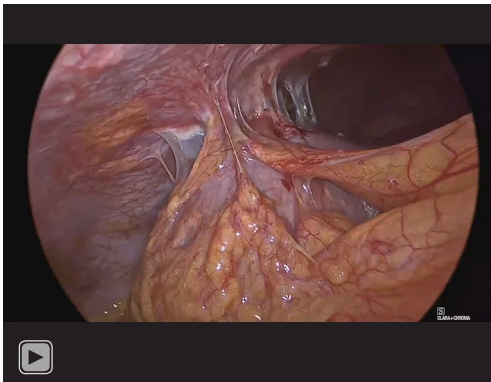
Some anatomical landmarks can help in performing a safe cholecystectomy. Between these, the “Rouvière’s sulcus” is a 2–5 cm sulcus running to the right side of the liver hilum, anterior to the caudate lobe; it was first described in 1924 by the French surgeon Henri Rouvière, and usually contains the right portal triad or its branches. It is present in 68% to 90% of patients and can be seen as a sulcus, scar, or slit. The dissection of the Calot’s triangle may be safely initiated upward this landmark (8,9).

Nevertheless, Rouvière’s sulcus is identified in just 75% of cases as it can be dimmed by inflammatory tissue or by omental fusion. So in recent times the Tokyo Guidelines (TG-18) suggest an imaginary diagonal line (D-line, which runs to the right border of the hilar plate and connects the base of segment IV of the liver to the ceiling of Rouvière’s sulcus) above which the gallbladder is dissected safely for gaining critical view of safety (CVS) without misidentification (10,11).

Another useful anatomic landmark for leading gallbladder dissection is the “Mascagni’s node” or “cystic lymph node”, which should represent the medial border of the dissection, lying lateral to the biliary tree (12) (*Video 1*).

Difficult cholecystectomy and difficult grading scale

Difficult laparoscopic cholecystectomy (DLC) is a distressing condition; its definition is not well established and may vary according to the surgeon’s experience. LC is the most practiced procedure in general surgery around the world. Also, if it is often considered a simple procedure with a rapid recovery, it can hide many pitfalls. Acute or chronic cholecystitis, adhesions due to previous abdomen surgeries,



Video 1 A huge cystic duct in acute cholecystitis closed using linear suture stapler.

Mirizzi's syndrome, and obesity are common clinical conditions associated with difficult cholecystectomy (13). By the way, longer operation time, difficulty in exploring Calot's triangle, conversion to open surgery are conditions that are usually termed as DLC by many surgeons (14-16).

Despite LC is a routine operation which however can put the surgeon in trouble, very few intra-operative difficulty scores have been published (17-19). It could be useful to use this kind of scale with the aim of assisting the surgeon in intra-operative planning and strategy, and also with the goal of standardize the sketch of operative evidence by different surgeons to simplify assessment training, audit and research. Among all the scales we would like to mention the Nassar operative difficulty scale (18) which assess operative findings from cystic pedicle, the gallbladder and associated adhesions (17). Bharamgoudar *et al.* have demonstrated that a higher difficulty grade has a significant clinical impact, being linked with worse clinical outcomes, regardless of any other factors on multivariable analysis (17).

The importance of CVS and other techniques for identifying anatomy

When it is possible, it is recommended to use the CVS (20) to identify biliary structures during surgery correctly. Three criteria characterize CVS:

- (I) The Calot triangle must be cleaned of all fatty and fibrous tissue, and the main bile duct must be identified but not exposed;
- (II) The gallbladder lower third must be separated from the liver bed to display cystic plate;
- (III) Only two structures have to be seen entering the

gallbladder.

CVS can be achieved in the majority of cases if tempted routinely. There is no evidence that seeking CVS is harmful and, therefore, its use is recommended. When the operative field is challenging and CVS cannot be obtained safely, alternative methods should be used to identify structures or conclude the intervention to avoid injuries (21). However, the degree of extension of the surgical dissection must be evaluated every single time.

Sometimes some surgeons prefer using the infundibular method to dissect close to the infundibulum of the gallbladder and reduce the risk of biliary injuries.

“Hidden cystic duct” is another anatomic syndrome characterized by a misleading appearance of a false infundibulum that could wrongly lead surgeons to mistake the CBD as the cystic duct (22).

Another technique which foresees that dissection of the gallbladder off its liver bed starting from the fundus far as to identify cystic duct and artery is the fundus first technique, also known as the dome-down technique (23-25). Nonetheless, in case of significant inflammation, notably in presence of scleroatrophic gallbladder with a merged hepato-cystic triangle, the surgeon can perform the dissection on the wrong plane, putting hilar structures at risk of injury (26,27).

Intraoperative biliary cholangiography (IOC) is strictly recommended in patients with acute cholecystitis (AC) or a history of it, or case of doubt about the anatomy of the biliary tract or suspicion of BDI during LC; IOC requires experience and equipment (28-30). However, the need for experience and the absence of randomized controlled trials have very limited its use (31,32). Still, laparoscopic ultrasound in expert hands allows the extrahepatic biliary tracts to be accurately mapped.

In recent years, a new technology, known as the near-infrared fluorescent (NIR) cholangiography with a indocyanine green (ICG) has taken hold in the field of fluorescence image-guided surgery for the intraoperative study of the extrahepatic biliary tree (33-35). Francesco Di Maggio and colleagues have showed how NIR-ICG can be a valuable tool also in an emergency setting, helping to point out biliary anatomy and improve the confidence of the surgeon in executing emergency cholecystectomies (36). Summing up, in spite of its safety and effectiveness have been proven in several studies (37) and also if it is cheaper and takes less time than IOC, there is no one imaging method that is superior to others. Besides it is essential to underline that these imaging methods are an integration to

the correct achievement of CVS and they must not replace a correct identification, even visual, of the anatomical structures during dissection.

Bailout strategies

When we are in front of a difficult gallbladder, it is more important to think about patient safety avoiding situation that could lead to biliary/vascular injury rather than think only to perform a complete cholecystectomy at all costs. In these challenging cases we have some alternative procedures to consider (bailout techniques), and the best option will depend on the expertise/experience of the surgeon and the clinical circumstance.

Convert to an open approach: some conditions must consider converting the intervention into laparotomy regardless of the approach used. In certain situations where a partial cholecystectomy is not technically feasible, such as a scleroatrophic gallbladder, inability to retract the gallbladder, or an impacted stone, a laparotomic conversion is mandatory (10,38). Before surgery, it would be important to establish which patients should be operated on directly with the open technique, which ones deserve an attempt in laparoscopy (39), and eventually how long to extend the laparoscopy before converting. Concerning the latter, there are no precise indications as no studies have focused their attention on this aspect. In any case, the decision to convert should be taken relatively early in the course of surgery to avoid any morbidity related to prolonged laparoscopy (17). We wrote before about IOC that can be useful to prevent conversion. Still, we must consider if the patient can tolerate a prolongation of times. For some surgeons, laparotomy conversion is perceived as a technical failure, when in reality, in the long term, this procedure may be the best choice for both the patient and the surgeon himself.

The “antegrade dissection”, also known as the “fundus first” or “dome-down” technique, represents another way to perform difficult cholecystectomies and consists in starting the dissection from the fundus of the gallbladder towards the infundibulum away from the Calot’s triangle (40). In this way, the gallbladder is pedunculated on the cystic duct and artery, clipped and cut in turn. Always remember, as mentioned above, that such a technique can mislead

“Partial or subtotal cholecystectomy” (both laparoscopy and laparotomic) is another safe, easy and definitive operation for challenging cholecystectomies recommended by both IRCAD and TG-18 guidelines (10,41,42). It consists in leaving behind a part of the gallbladder rather than incur in

a hazardous dissection in the epatocystinc triangle, leading to potential structures injuries. In subtotal reconstituting cholecystectomy the suture of the infundibulum (with stapler or suture) is performed 1 cm from the cystic duct (43). When this technique is used, particular attention must be paid to the length of the infundibulum that is left in place, which if it is too long (3–4 cm) increases the risk of small residual stones, or the formation of new ones, which may also require of re-interventions (44). It is not always technically feasible because the cystic duct is not constantly clearly recognizable in a diffuse inflammation (45).

Another technique that can be used in these cases is known as fenestration. The gallbladder can be left in place, especially the posterior wall, and the cystic duct can be closed from within. This technique exposes the risk of stenosis of the nearby CBD due to the retraction of the duct (44).

Pivotal points of these bailout techniques are to ablate with diathermy or argon plasma the remaining gallbladder mucosa, to dislodge all the stones and to keep the gallbladder stump as short as possible.

Cholecystostomy: the positioning of a tube, whether laparoscopic or laparotomic, is a mere bridge workflow to soothe until a final procedure is carried out, recalling that, however, subsequent intervention can be equally difficult (46).

Biliary and vascular injury

BDI are harmful complications of cholecystectomy, whose incidence increased with the advent of laparoscopy (0.4–1.5% of cases) confronted with open approach (0.2–0.3% of cases) (47–50). Although the frequency of BDI has been reduced recently (0.32–0.52%) (4–6), they are still associated with high mortality, morbidity and long-term quality of life (51–53). It is important to provide an early diagnosis and accurate description of the BDI in order to facilitate subsequent surgical decisions, increasing the chances of successful treatment (38).

Several risk factors can contribute to the iatrogenic vascular and biliary duct injuries:

- ❖ Patient-related factors: obesity, liver diseases, previous biliary surgery;
- ❖ AC, and its associated anatomical changes, such as adhesions, tissues thickening, bleeding, inflammation (54,55);
- ❖ The laparoscopic approach requires an appropriate learning curve (56);
- ❖ Human factors related to the surgeons include excessive safety, rush to finish, fatigue, personal

problems, anxiety, superficiality, and obstinacy in not converting into a laparotomy (57,58);

- ❖ Anatomical factors;
 - ♦ Vascular anomalies: the cystic artery in most cases derives from right hepatic artery (RHA) and then breaks down into two branches, one superficial and one deep (59). However, there are many variants (60) that we need to know. Also an aberrant RHA is common (RHA usually lies behind the common hepatic duct (CHD) in 87% of cases before come in the hepatocystic triangle);
 - Findings and suggestions: most commonly, vascular lesions during dissection of the Calot triangle in LC involve the RHA. Portal vein injuries are rare and often associated with RHA injuries (61,62). RHA can be cauterized, closed, or dissected, usually mistaken for the cystic artery, during cauterization maneuvers, or for poor vision. The formation of an RHA pseudoaneurysm is a possible complication that often causes intraperitoneal or gastrointestinal bleeding. It is appropriate to maintain the sealing of the cystic artery on the right edge of the cystic lymph node in order to prevent injury to RHA;
 - ♦ Biliary tract anomalies: the cystic duct commonly joins common hepatic duct (CHD) forming an angle, but its course and length may change and can be parallel (22%) or spiral (5%). Another variant that can lead to deception is the presence of anomalous right posterior sectional duct (60,63);
 - Findings and suggestions: LC does not involve the isolation of the junction between cystic duct and common biliary duct (CBD) because this may put the latter at risk of injury, particularly in the event of a parallel decourse of the cystic duct. Another tip is that if the cystic duct cannot be detected, the causes can be that it is short or we may be in the presence of a Mirizzi syndrome. In this situation the surgeon should pay close attention in dissecting the epato-cystic triangle and he/she may need to use one of the bail-

out procedures as outlined later.

Most BDI are identified during the surgery or in the foreseeable postoperative period and usually they commonly presented with two clinical setting: bile leak or bile duct obstruction (51).

In case of BDI discovered during LC the surgeon must readily examine the type and extension of the injury and opt between intraoperative repair or “drain now and fix later” plan of action, this latter especially when the surgeon is not an hepato-pancreato-biliary expert (64).

Citing among the most common and less serious BDI, a frequent complication of LC is cystic duct leakage (CDL), which is reported in 0.5–3% of patients following LC (65,66). Recent evidence shows that the CDL rate rises to 4–7% in patients with gallbladder lithiasis complicated by acute or chronic inflammatory conditions, cholangitis, pancreatitis, or associated lithiasis of the main biliary tract (67–69). Although CDL represents a minor lesion of the biliary tract, it still involves a high rate of reoperation, morbidity, and mortality (28,52,70). CDL can be considered an avoidable complication through a proper and safe closure of the cystic duct during LC.

Today the use of non-absorbable and non-locking metal clips represents the standard for the closure of the cystic duct in many surgery units worldwide (71). Alternatives can be represented by: metallic or polymeric locking clips, ligatures (68,69) or ultrasound sealing devices (72,73).

The evidence in the literature on alternative cystic duct closure techniques is minimal and of insufficient quality to recommend a specific one.

In our experience, we usually use single metal clips; when the cystic duct diameter is more than 5 mm, we prefer to use a linear vascular stapler, two ligatures performed with extracorporeal Roeder knot, or metallic locking clips. The particular closing characteristic of the latter allows repositioning of the clip and reduces the risk of tissue slippage out of the clip. Eventually, clips with a latch preventing clip slipping are available for selective clip sizes. In case of fragile cystic duct the authors suggest to close up the duct with absorbable monofilament suture.

Role of the drainage

Even though LC is one of the most commonly performed procedures, the standard position of the drain after this procedure, is still an issue of considerable debate.

The rationale behind positioning the surgical drainage in the liver bed after cholecystectomy is to avoid the formation

of blood and/or biliary collections that can subsequently become infected and require radiological procedures or even reoperation (74). Another usage of the drainage is to allow the complete release of residual CO₂, which could cause peritoneal irritation with consequent nausea and/or pain in the shoulder after surgery (75). At the same time, the positioning of the drainage can have negative aspects: vascular and intestinal injuries due to decubitus or excessive aspiration, a vehicle for any intra-abdominal infections, malpositioning with the inability to drain contiguous collections, pain or potentially hidden lesions during its removal. Furthermore, the omentum may block the drain within 48 hours (76). Therefore, the absence of bile or blood in the collection container does not always indicate the lack of complications.

If, as mentioned before, drainage can, on the one hand, reduce postoperative pain by allowing CO₂ to escape, on the other hand, it can increase it by irritating the skin and peritoneum.

In general, the most recent guidelines and the opinion of most experts are against the routine use of drainage after elective and uncomplicated cholecystectomy (77,78). As for the use of drainage in the context of acute inflammation, the argument is more controversial, and there are no clear indications from the literature (79). Specific indications are missing in the most recent guidelines (10,80,81). For all these observations, the use of drainage after cholecystectomy for AC remains at the surgeon's discretion, based on his own experience.

Concerning the role of the drain in reducing post-laparoscopy shoulder pain (PLSP), although some authors demonstrated that it significantly reduced the frequency and intensity of the pain in the first 24 hours (82), we deem that the maneuver about passive expel residual intra-peritoneal gas through trocars left opened at the end of the laparoscopic procedure is enough to minimize the PLSP. In our experience, we believe it is appropriate to drain in situations where there is expected to be a bile leak or bleeding to avoid irritation of the peritoneum. This is definitely the case of complicated cholecystectomy in which identifying the structures is difficult, but also in the case of uncomplicated LC where the gallbladder is accidentally opened.

Conclusions

Although LC is nowadays the optimum surgical procedure for symptomatic gallbladder lithiasis, it should not be

underestimated since vascular and biliary duct injuries are very morbid, significantly increase care costs, and often lead to litigation. The repercussions can be catastrophic for an ordinarily outpatient procedure, where a quick return to daily activities is expected. In this study we described several surgical technical approach for LC according to the intraoperative situation to avoid accidental anatomical structures injuries. Therefore, we always consider these recommendations and bailout procedures as an optional approach to prevent vascular and/or biliary duct injuries, considering that the best option will depend on the expertise/experience of the surgeon and the clinical circumstance.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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