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# Solve study: a study to capture global variations in practices concerning laparoscopic cholecystectomy

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## Abstract

**Background** There is a lack of published data on variations in practices concerning laparoscopic cholecystectomy. The purpose of this study was to capture variations in practices on a range of preoperative, perioperative, and postoperative aspects of this procedure.

**Methods** A 45-item electronic survey was designed to capture global variations in practices concerning laparoscopic cholecystectomy, and disseminated through professional surgical and training organisations and social media.

**Results** 638 surgeons from 70 countries completed the survey. Pre-operatively only 5.6% routinely perform an endoscopy to rule out peptic ulcer disease. In the presence of preoperatively diagnosed common bile duct (CBD) stones, 85.4% (n = 545) of the surgeons would recommend an Endoscopic Retrograde Cholangio-Pancreatography (ERCP) before surgery, while only 10.8% (n = 69) of the surgeons would perform a CBD exploration with cholecystectomy. In patients presenting with gallstone pancreatitis, 61.2% (n = 389) of the surgeons perform cholecystectomy during the same admission once pancreatitis has settled down. Approximately, 57% (n = 363) would always administer prophylactic antibiotics and 70% (n = 444) do not routinely use pharmacological DVT prophylaxis preoperatively.

Open juxta umbilical is the preferred method of pneumoperitoneum for most patients used by 64.6% of surgeons (n = 410) but in patients with advanced obesity (BMI > 35 kg/m$^2$, only 42% (n = 268) would use this technique and only 32% (n = 203) would use this technique if the patient has had a previous laparotomy. Most surgeons (57.7%; n = 369) prefer blunt ports. Liga clips and Hem-o-loks® were used by 66% (n = 419) and 30% (n = 186) surgeons respectively for controlling cystic duct and (n = 477) 75% and (n = 125) 20% respectively for controlling cystic artery. Almost all (97.4%) surgeons felt it was important or very important to remove stones from Hartmann's pouch if the surgeon is unable to perform a total cholecystectomy.

**Conclusions** This study highlights significant variations in practices concerning various aspects of laparoscopic cholecystectomy.

**Keywords** Cholecystectomy · Gallstone disease · Gallbladder surgery · Variation in practice · Cholecystitis · Obstructive jaundice · Gallstone pancreatitis

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The first laparoscopic cholecystectomy was performed in the world in 1985 [1]. Since then, there have been many changes and developments in practices concerning this procedure. Technological advancements have played a key role in the evolution of laparoscopic cholecystectomy over the last three decades [2].

It is now one of the commonest surgical procedures performed worldwide, with approximately 66,000 procedures performed annually in the United Kingdom alone [3]. Despite this, there is a lack of agreement amongst surgeons on its various aspects [4, 5]. These variations in practices may account for the differences in key outcome measures, such as the morbidity rates, mortality rates, re-intervention rates, and readmission rates in different parts of the world [6, 7]. Any variation in practice is also an opportunity to identify the best practice through focussed studies.

There are studies formally evaluating global variations in practices on a range of surgical procedures [8, 9]. However, to the best of our knowledge, there is no study in the scientific literature capturing global variations in practices concerning laparoscopic cholecystectomy. This may have adversely impacted our ability to determine best practices concerning this procedure and standardise clinical pathways and surgical steps. Knowing the full range of variations in practices is often the first step toward determining the practice associated with the best outcomes. Knowledge of all the variations in practices may also be potentially useful in medicolegal cases especially if the practice of the surgeon is different from that of the "experts".

We, therefore, designed a global survey to understand variations in a range of preoperative, intraoperative, and postoperative practices concerning laparoscopic cholecystectomy.

## Materials and methods

We designed a 45-item survey on www.planetsurvey.com. Survey questions and options were suggested by all the authors and finalised after several rounds of internal discussions and pilot testing. Responses to each question included most of the common options authors were aware of. We further provided an option to submit "other" variations that we were potentially not aware of for each question.

The survey link was freely shared by authors within their personal network, through Twitter® and on groups of general surgeons on Facebook®, LinkedIn®, and Google®, and through mailing lists of professional societies such as The Upper Gastrointestinal Surgeons (TUGS), Association of Laparoscopic Surgeons of Great Britain and Ireland (ALSGBI), and Association of Upper Gastrointestinal Surgeons (AUGIS). The survey was made live on 10th February 2021 and closed for analysis on 7th May 2021.

Any healthcare professional performing laparoscopic cholecystectomy, irrespective of their country of practice or grade was invited to participate in the survey. Those who do not perform laparoscopic cholecystectomy were asked to leave the survey. No identifiable information was collected, and no attempt was made to identify individual responses. Standard descriptive statistics were used.

Some of the terms used in this study may be more commonly used in the United Kingdom and therefore merit further clarification. For example, "hot gall bladder" means acute presentation with a condition that would generally merit an emergency laparoscopic cholecystectomy; "swift list" means dedicated emergency access to operating theatres for patients needing laparoscopic cholecystectomy for a "hot gall bladder", and "*separate Upper GI rota*" means availability of surgeons to carry out laparoscopic cholecystectomy on an emergency basis. Typically, these are upper gastrointestinal surgeons.

## Results

### Characteristics of participating surgeons

A total of 638 healthcare professionals from 70 countries took the survey. Of these, 28.4% (n = 179) respondents were from the United Kingdom, followed by India (n = 80, 12.7%), Egypt (50, 7.9%) and Italy (n = 24, 3.8%). Figure 1 provides the regional distribution of the respondents. Of these, 54.3% (n = 373) respondents had provision for theatre access for emergency laparoscopic cholecystectomy in their hospitals. At the same time, 72.8% (n = 464) of respondents mentioned that they did not have surgeons available to carry out emergency laparoscopic cholecystectomy in their institution.

### Preoperative practices

Table 1 lists all the responses to preoperative practices. Ultrasound scan (US) was the preferred diagnostic modality for patients with biliary colic for 96.7% (n = 617) of the respondents. Most (n = 546, 85.6%) of the respondents would only perform preoperative Oesophago-Gastro-Duodenoscopy (OGD) to rule out Peptic Ulcer Disease (PUD) if the patient has atypical symptoms.

For acute cholecystitis, Ultrasound Scan (US) was the diagnostic modality of choice according to 87.1% (n = 556) of the respondents. Magnetic resonance cholangiopancreatography (MRCP) was the preferred modality for calculous obstructive jaundice (n = 423, 66.3%). In the presence of preoperatively diagnosed common bile duct (CBD) stones, 85.4% (n = 545) of the surgeons would recommend an

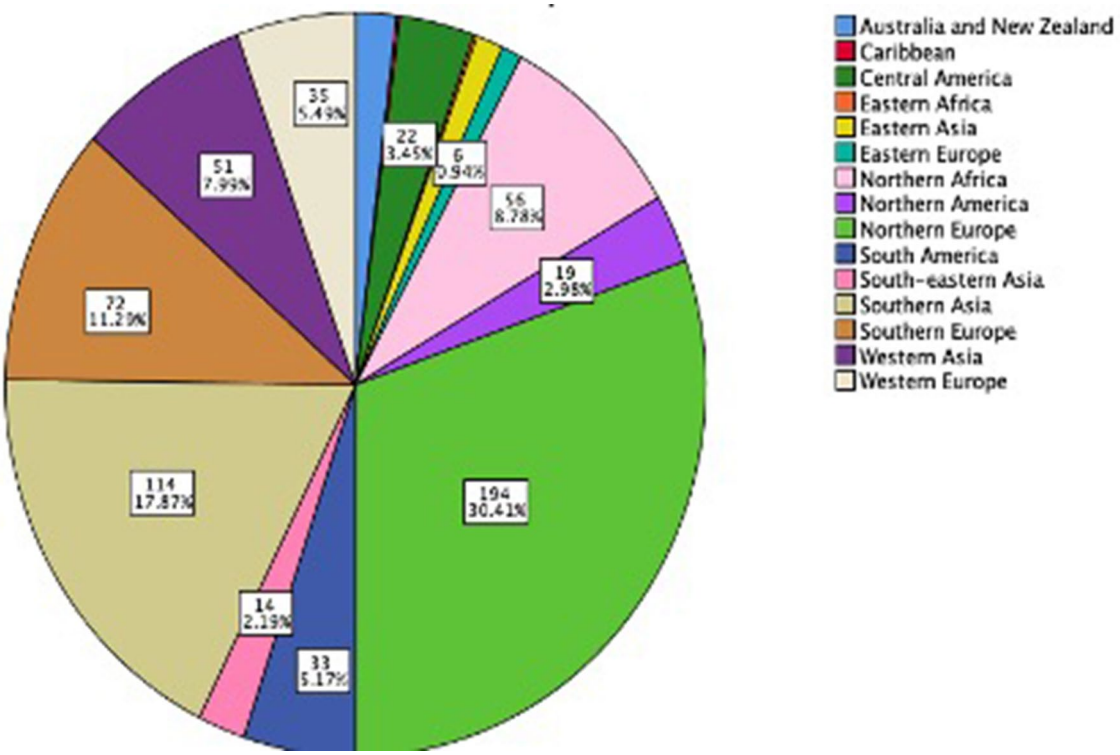


**Fig. 1** Regional distribution of the participatory surgeons

Endoscopic Retrograde Cholangio-Pancreatography (ERCP) before surgery, while 10.8% (n = 69) of the surgeons would perform a CBD exploration with cholecystectomy. Similarly, for asymptomatic choledocholithiasis diagnosed on an intraoperative cholangiogram, most (n = 208; 32.6%) would perform a cholecystectomy followed by an ERCP.

In patients presenting with gallstone pancreatitis, 61.2% (n = 389) of the surgeons perform cholecystectomy during the same admission once pancreatitis has settled down. Most (79%; n = 325) would use a combination of clinical status and inflammatory markers to determine the resolution of pancreatitis.

## Intraoperative and postoperative practices

All intraoperative and postoperative variations in practices are listed in Table 2. Over half of the respondents (57%; n = 363) always recommended prophylactic antibiotics. Others had specific indications for this such as empyema of the gallbladder (54%; n = 243), major spillage of gall bladder content (41%; n = 185), and even minor spillage (36.8%; n = 166). Cefuroxime (n = 236, 37.2%) and amoxicillin/clavulanic acid (Co-amoxiclav) (n = 229, 36.1%) were the most commonly used antibiotics in the absence of penicillin allergy. In case of mild penicillin allergy Cefuroxime (n = 286, 45.8%) and Teicoplanin (n = 105, 16.8%) were commonly used. (It should be noted that administration of cephalosporins in such cases is not contraindicated as the cross-reactivity is only 1%). Regarding deep venous thrombosis (DVT) prophylaxis, most of the respondents (n = 444, 69.7%) do not routinely use pharmacological DVT prophylaxis before surgery or induction.

Open juxta umbilical (infra, supra, or trans) was the most preferred method for creating pneumoperitoneum (n = 410, 64.6%). Fewer respondents (n = 268, 42%) would however use this approach in patients with BMI > 35 kg/m$^2$. Blunt tip disposable (n = 221, 34.7%) and reusable ports (n = 148, 23.2%) were the most used types. Bladed ports were only used by 17.6% of the respondents (n = 112).

Dissection of the Calot's triangle was predominantly done using hook diathermy by most of the surgeons (n = 374, 58.8%), and 34.3% of surgeons (n = 218) preferred blunt dissection using a laparoscopic dissector. Most surgeons (57.7%; n = 369) prefer blunt ports. Liga clips and Hem-o-loks® were used by 66% (n = 419) and 30% (n = 186) surgeons respectively for controlling cystic duct and (n = 477) 75% and (n = 125) 20% respectively for controlling cystic artery. The most common approach to difficult Calot's triangle was retrograde dissection from the fundus (49.2%, n = 312). In cases of CBD injury detected intraoperatively, one-third of surgeons (n = 214) would repair the injury themselves.

**Table 1** Participants and Preoperative Considerations

| | Questions | Response | | Total responses |
|---|---|---|---|---|
| | | Category | Number | |
| 1 | Please confirm that you are a surgeon who performs cholecystectomy | Yes | 638 | 638 |
| | | No | 0 | |
| 2 | Which country do you work in? | Please See Fig. 1 | | 630 |
| 3 | Do you have provisions for swift lists for hot gall bladders in your hospital? | Yes | 373 (54.3%) | 638 |
| | | No | 236 (37%) | |
| | | Other | 28 (4.3%) | |
| 4 | Do you have a separate Upper GI rota for dealing with emergency patients with gallstone disease? | Yes | 158 (24.8%) | 637 |
| | | No | 464 (72.84%) | |
| | | Other | 15 (2.4%) | |
| 5 | What is your preferred diagnostic modality for patients with biliary colic? | Ultrasound Scan | 617 (96.7%) | 638 |
| | | CT scan | 11 (1.7%) | |
| | | MRI scan | 8 (1.2%) | |
| | | Other | 2 (0.3%) | |
| 6 | Do you perform an Oesophago-Gastro-Duodenoscopy (OGD) in patients to rule out Peptic Ulcer Disease before offering surgery? | Only if patient has atypical symptom(s) | 546 (85.57%) | 638 |
| | | Never | 44 (6.9%) | |
| | | Yes Always | 36 (5.6%) | |
| | | Other | 12 (1.8%) | |
| 7 | What is your preferred diagnostic modality for patients with acute cholecystitis? | Ultrasound Scan | 556 (87.1%) | 638 |
| | | CT Scan | 67 (10.5%) | |
| | | Other | 9 (1.4%) | |
| | | MRI Scan | 6 (0.9%) | |
| 8 | What is your preferred diagnostic modality for patients presenting with obstructive? jaundice suspected to be due to gallstone disease? | MRI Scan | 423 (66.3%) | 638 |
| | | Ultrasound Scan | 121 (19%) | |
| | | CT Scan | 49 (7.6%) | |
| | | Others | 45 (6.7%) | |
| 9 | What is your preferred approach for patients with known (diagnosed preoperatively) choledocholithiasis (keeping in mind patients where all options would be appropriate)? | ERCP followed by Cholecystectomy | 545 (85.4%) | 637 |
| | | Cholecystectomy + CBD exploration | 69 (10.8%) | |
| | | Other | 24 (3.7%) | |
| 10 | What is your preferred approach for patients with asymptomatic choledocholithiasis diagnosed intraoperatively on a cholangiogram? (Keeping in mind patients where all options would be appropriate) | Cholecystectomy followed by ERCP | 208 (32.6%) | 638 |
| | | Cholecystectomy + CBD exploration | 182 (28.5%) | |
| | | I never do an intraoperatively cholangiogram | 178 (27.9%) | |
| | | Other | 38 (6%) | |
| | | Cholecystectomy followed by MRCP to confirm choledocholithiasis | 32 (5%) | |
| 11 | Do you have a period of mandatory waiting after an ERCP before you perform cholecystectomy? | Planned elective cholecystectomy with timing of surgery dependent on indication for ERCP in patient who present with gallstone(s) complications | 204 (32%) | 637 |
| | | No | 189 (29.6%) | |
| | | Yes at least 24 h | 140 (21.9%) | |
| | | Yes at least 48 h | 82 (12.8%) | |
| | | Other | 22 (3.4%) | |
| 12 | What is your preferred approach for patients presenting with gallstone pancreatitis? | Cholecystectomy during the same admission after pancreatitis is settled | 389 (61%) | 636 |
| | | Elective Cholecystectomy after discharge | 144 (22.6%) | |
| | | Expedited Cholecystectomy within 14 days after discharge | 82 (12.85%) | |
| | | Other | 21 (3.3%) | |

**Table 1** (continued)

| | Questions | Response | | Total responses |
|---|---|---|---|---|
| | | Category | Number | |
| 13 | How do you decide that pancreatitis has settled? | A combination of clinical and inflammatory parameters | 325 (79%) | 411 |
| | | Clinically | 74 (18%) | |
| | | Based on inflammatory markers | 7 (1.7%) | |
| | | Other | 5 (1.2%) | |

### Qualitative analysis of free-text answers

Table 3 describes the thematic qualitative analysis of free-text answers for preoperative, intraoperative, and postoperative practices.

## Discussion

This survey is the first global study capturing variations in practices concerning laparoscopic cholecystectomy. With 638 surgeons from 70 countries worldwide, we believe we have captured a representative sample and are unlikely to have missed any common variation. This knowledge will enable future work to determine best practices in the performance of laparoscopic cholecystectomy.

With the growing evidence favouring early intervention after acute presentations of gallstone disease [10–13], many practice guidelines have recommended establishing emergency cholecystectomy pathways for early cholecystectomy for patients presenting acutely with symptomatic gall bladder disease [14, 15]. This survey shows that emergency access to operating theatres for this purpose was not available in the institution of approximately a third of the respondents. Similarly, two-thirds of the respondents mentioned that they did not have the availability of emergency surgeons who could perform these operations in their hospitals. These figures are sobering statistics regarding the management of a common general surgical emergency.

The current Association of Upper GI Surgeons (AUGIS) guidelines in the United Kingdom [15] recommend liver function tests and the abdominal US as primary investigations for suspected biliary colic. In this survey, most respondents (617) report their preference for the US as an initial diagnostic modality for biliary colic. For acute cholecystitis, 87% favour the use of US, while 10.5% prefer CT scans. Tokyo guidelines [16] recommend the US as the first-choice imaging method for diagnosing acute cholecystitis due to its widespread availability, ease of use, lack of radiation, and cost-effectiveness. However, the diagnosis of gallstone disease can be challenging when the patients present with atypical symptoms that can mimic peptic ulcer disease or gastritis. That is why some surgeons routinely recommend OGD to rule out these conditions before planning gallbladder surgery [17]. However, this survey shows that such surgeons are in a minority with only 36/638 (5.6%) surgeons recommending a routine OGD before surgery.

When asked about the best modality for investigating patients presenting with obstructive jaundice, unsurprisingly the majority (66.3%; 423/638) preferred an MRCP, which is known to be more sensitive for the diagnosis of choledocholithiasis than a US or CT scan [18]. For patients with CBD stones, a single-stage cholecystectomy and surgical bile duct clearance is feasible, cost-effective, and may even be associated with a shorter hospital stay compared to a two-stage ERCP and cholecystectomy approach [14]. Yet it is not the preferred approach of most of the surgeons who took this survey with a clear majority (545/637; 85.6%) preferring staged management with ERCP followed by cholecystectomy. This could be due to a relative lack of expertise needed to explore CBD laparoscopically and/or non-availability of equipment. Regarding the time interval from CBD clearance to cholecystectomy, there was again a huge variation in practice. This probably reflects a lack of clear evidence to guide practice in this area [19–22].

Three hundred eighty-nine surgeons (61%) reported that they would perform cholecystectomy in the index admission after resolution of gallstone pancreatitis, and 82 (12.9%) would do so within two weeks. Early gallbladder removal after biliary pancreatitis is associated with fewer 30-day readmissions [10], shorter hospital stay [11], fewer gallstone-related events, and lower ERCP usage [23]. It is, therefore, interesting that some surgeons are not yet able to offer this to their patients.

The incidence of surgical site infection after gallbladder surgery has been reported to be higher with open cholecystectomy compared to keyhole surgery, ranging from 0.3% to 3.4% for the latter and 1.1% to 8.4% for the former [24, 25]. However, currently available evidence does not support routine prophylactic antibiotics for cholecystectomy [26]. Vohra et al. reported that antibiotic prophylaxis significantly reduced the rates of superficial SSI and all-cause

**Table 2** Variations in the intra and postoperative practices

| SN | Question | Response | | Total Number of Responses |
|---|---|---|---|---|
| | | Category | Number | |
| 14 | Do you give prophylactic antibiotics? | Yes always | 363 (57%) | 637 |
| | | Yes sometimes | 92 (14.4%) | |
| | | Yes, most of the times | 61 (9.6%) | |
| | | Rarely | 55 (8.6%) | |
| | | Other | 46 (7.2%) | |
| | | Never | 20 (3.1%) | |
| 15 | If you don't always give prophylactic antibiotics, how do you decide to give it? | If there is empyema of the gall bladder | 243 (54%) | 451 |
| | | If there is major spillage of gall bladder content during the surgery | 185 (41%) | |
| | | If there even minor spillage of gall bladder content during the surgery | 166 (36.8%) | |
| | | Other (Please comment in the box) | 109 (24.2%) | |
| | | If it is a difficult surgery | 78 (17.3%) | |
| | | If it is a prolonged surgery | 63 (14%) | |
| 16 | Which antibiotic do you recommend for individuals not allergic to penicillin? | Cefuroxime | 236 (37.2%) | 635 |
| | | Co-amoxiclav | 229 (36%) | |
| | | Other (Please name it in the comment box) | 170 (26.8%) | |
| 17 | Which antibiotic do you recommend for individuals with mild penicillin allergy? | Cefuroxime | 286 (45.8%) | 624 |
| | | Other (Please name it in the comment box) | 233 (37.34%) | |
| | | Teicoplanin | 105 (16.8%) | |
| 18 | Do you routinely (if not contraindicated) administer pharmacological DVT prophylaxis before the surgery/ induction of anaesthesia? | No | 444 (70%) | 637 |
| | | Yes | 167 (26.2%) | |
| | | Other (Please comment in the box) | 26 (2.8%) | |
| 19 | Do you routinely (if not contraindicated) use elastic compression stockings? | Yes | 336 (53%) | 633 |
| | | No | 291 (46%) | |
| | | Other (Please comment in the box) | 6 (1%) | |
| 20 | Do you routinely (if not contraindicated) use intermittent compression devices? | No | 442 (69.4%) | 637 |
| | | Yes | 181 (28.4%) | |
| | | Other (Please comment in the box) | 14 (2.2%) | |
| 21 | What is your preferred method of pneumoperitoneum? | Open juxta-umbilical (infra, supra, or trans) | 410 (64.6%) | 635 |
| | | Closed using a Veress needle followed by a non-optical trocar insertion | 115 (18%) | |
| | | Closed using a Veress needle followed by an optical trocar insertion | 76 (12%) | |
| | | Closed pneumoperitoneum using an optical trocar | 16 (2.5%) | |
| | | Other (Please name it in the comment box) | 12 (1.8%) | |
| | | Open elsewhere in the abdomen | 6 (1%) | |
| 22 | What is your preferred method of pneumoperitoneum in patients suffering from advanced obesity (BMI > 35 kg/m$^2$)? | Open juxta-umbilical (infra, supra, or trans) | 268 (42%) | 637 |
| | | Closed using a Veress needle followed by a non-optical trocar insertion | 111 (17.8%) | |
| | | Closed pneumoperitoneum using an optical trocar | 69 (10.8%) | |
| | | Closed using a Veress needle followed by an optical trocar insertion | 163 (2.6%) | |
| | | Other (Please provide details it in the comment box) | 14 (2.2%) | |
| | | Open elsewhere in the abdomen | 12 (1.8%) | |

**Table 2** (continued)

| SN | Question | Response | | Total Number of Responses |
|---|---|---|---|---|
| | | Category | Number | |
| 023 | What is your preferred (in most patients) method of pneumoperitoneum in patients who have had previous midline laparotomy? | Open juxta-umbilical (infra, supra, or trans) | 203 (32%) | 636 |
| | | Open elsewhere in the abdomen | 145 (22.8%) | |
| | | Closed using a Veress needle followed by an optical trocar insertion | 138 (21.7%) | |
| | | Closed pneumoperitoneum using an optical trocar | 70 (11%) | |
| | | Other (Please provide details it in the comment box) | 48 (7.5%) | |
| | | Closed using a Verees needle followed by a non-optical trocar insertion | 32 (5%) | |
| 24 | What type of ports do you use? | Blunt tip disposable ports | 221 (34.7%) | 637 |
| | | Blunt tip reusable ports | 148 (23%) | |
| | | Non-bladed sharp tip ports | 139 (21.8%) | |
| | | Bladed ports | 112 (17.6%) | |
| | | Other (Please name it in the comment box) | 17 (2.7%) | |
| 25 | How many ports do you routinely use? | 4 | 559 (87.8%) | 637 |
| | | 3 | 67 (10.5%) | |
| | | 2 | 8 (1.25%) | |
| | | Other (Please provide details in details box) | 2 (0.3%) | |
| | | 5 | 1 (0.15%) | |
| | | Single Port | 0 (0%) | |
| 26 | Do you pre-infiltrate port sites with Local Anaesthetic? | Yes | 296 (46.5%) | 637 |
| | | No | 178 (28%) | |
| | | I put local anaesthetic at the end of the procedure | 133 (20.8%) | |
| | | I do not use any local anaesthetic for the port sites | 19 (3%) | |
| | | Other (Please provide details in the comment box) | 11 (1.7%) | |
| 27 | What is your preferred (dominant) technique of dissection in Calot's triangle? | Hook and Diathermy | 374 (59%) | 636 |
| | | Blunt Dissection using a laparoscopic (Maryland for example) dissector | 218 (34%) | |
| | | Other method (Please provide details in the comment box) | 44 (7%) | |
| 28 | What is your preferred method for controlling Cystic Artery? | Liga Clips | 477 (75%) | 637 |
| | | Hemo-o-locks | 125 (20%) | |
| | | Other (Please provide details in the comment box) | 35 (5%) | |
| 29 | What is your preferred method for controlling Cystic Duct? | Liga Clips | 419 (66%) | 637 |
| | | Hemo-o-locks | 186 (30%) | |
| | | Other | 22 (3.3%) | |
| | | Tie-in-continuity | 10 (1.7%) | |
| 30 | How do you approach a difficult Calot's triangle? | Retrograde dissection from fundus | 312 (49%) | 634 |
| | | Persevere with Calot's triangle | 145 (23%) | |
| | | Transect gall bladder in the middle and retrograde dissection from there | 114 (18%) | |
| | | Other | 63 (10%) | |
| 31 | How do you approach a Hartmann's pouch densely adherent to common hepatic/ common bile duct? | Retrograde dissection from fundus | 289 (46%) | 630 |
| | | Transect gall bladder in the middle and retrograde dissection from there | 165 (26%) | |
| | | Persevere with Calot's triangle | 104 (16.5%) | |
| | | Other | 72 (11.5%) | |

**Table 2** (continued)

| SN | Question | Response | | Total Number of Responses |
|---|---|---|---|---|
| | | Category | Number | |
| 32 | How important is it in your opinion to remove all gallbladder wall adherent to structures in Calot's triangle? | Not Important (only remove if it is safely possible) | 440 (69%) | 636 |
| | | Important (dissect carefully even if it takes some time and may risk injury to surrounding structures) | 103 (16%) | |
| | | Very important (convert if necessary) | 76 (12%) | |
| | | Other | 17 (2.6%) | |
| 33 | How important is it in your opinion to remove all gallbladder wall adherent to liver bed? | Not important (only remove if it is safely possible) | 466 (73.4%) | 635 |
| | | Important (dissect carefully even if it takes some time and may risk injury to surrounding structures) | 128 (20.2%) | |
| | | Very important (convert if necessary) | 34 (5.3%) | |
| | | Other | 7 (1.2%) | |
| 34 | Do you cauterise mucosa of any gallbladder wall left behind? | Yes, as much as possible | 329 (51.7%) | 636 |
| | | Yes, meticulously | 163 (26%) | |
| | | Yes, but I am not really bothered | 107 (17%) | |
| | | No | 35 (5.5%) | |
| | | Other | 2 (0.3%) | |
| 35 | How important is it in your opinion to remove all stones stuck in the Hartmann's pouch for prevention of future attacks of biliary colic/cholecystitis (if you are unable to perform a total cholecystectomy)? | Very important | 466 (73.4%) | 635 |
| | | Important | 153 (24%) | |
| | | Not important | 8 (1.25%) | |
| | | Other | 8 (1.25%) | |
| 36 | How important is it in your opinion to remove all small stones spilled during a cholecystectomy? | Very important | 349 (54.7%) | 637 |
| | | Important | 241 (37.8%) | |
| | | Not important | 41 (6.4%) | |
| | | Other 6 1% | | |
| 37 | How do you deal with CBD injury detected intraoperatively? | Try to repair it yourself | 214 (33.6%) | 636 |
| | | Stop, leave a drain and send the patient to a tertiary centre | 174 (27.4%) | |
| | | Call the tertiary centre while the patient is on table | 166 (26.1%) | |
| | | Other | 82 (12.9%) | |
| 38 | What do you use to retrieve the gallbladder? | In a laparoscopic retrieval bag (such as a BERT bag) | 452 (71%) | 636 |
| | | Other | 28 (4%) | |
| | | without a retrieval bag | 156 (25%) | |
| 39 | If you use a laparoscopic retrieval bag, is this included in your theatre operating count? | Yes | 428 (69.4%) | 617 |
| | | Other | 14 (21.3%) | |
| | | Not sure | 95 (15.4%) | |
| | | No | 80 (13%) | |
| 40 | Do you use local anaesthetic in the GB bed/intra-abdominally? | No | 538 (84.5%) | 636 |
| | | Yes | 90 (14%) | |
| | | Other | 8 (1.5%) | |
| 41 | Which port do you use to retrieve the GB? | Juxta Umbilical Port | 387 (61%) | 637 |
| | | Epigastric Port | 236 (37%) | |
| | | Other | 14 (2%) | |
| 42 | Do you routinely leave a drain? | No | 551 (86.8%) | 635 |
| | | Yes | 78 (12.3%) | |
| | | Other | 6 (9.4%) | |
| 43 | Do you ask anaesthetist to ensure a normal blood pressure at the end of the procedure to check for adequate haemostasis? | No | 315 (49.6%) | 635 |
| | | Yes | 302 (47.6%) | |
| | | Other | 18 (2.8%) | |

**Table 2** (continued)

| SN | Question | Response | | Total Number of Responses |
|---|---|---|---|---|
| | | Category | Number | |
| 44 | Do you close the sheath in the epigastric port? | No | 306 (48.1%) | 636 |
| | | Yes | 277 (43.6%) | |
| | | Other | 53 (8.3%) | |
| 45 | How do you prefer to close the skin? | Subcuticular | 348 (54.8%) | 635 |
| | | Interrupted sutures | 172 (27%) | |
| | | Surgical clips | 80 (12.6%) | |
| | | Glue | 24 (3.8%) | |
| | | Other | 11 (1.7%) | |
| 46 | What is your routine protocol for discharging patients undergoing elective lap cholecystectomies? | Next day | 319 (50%) | 636 |
| | | Same day | 283 (44.5%) | |
| | | Other | 35 (5.5%) | |
| 47 | Do you offer a planned clinic follow up? | Yes | 417 (65.6%) | 636 |
| | | No | 207 (32.5%) | |
| | | Other | 12 (2.8%) | |
| 48 | How long do you give antibiotics for patients with cholecystitis after surgery? | I stop antibiotics after surgery | 279 (43.8%) | 637 |
| | | Finish the course | 184 (28.9%) | |
| | | Two more dose | 142 (22.3%) | |
| | | Other | 32 (5%) | |
| 49 | Do you have any other thoughts regarding this survey? | See qualitative analysis (Table 3) | | 634 |

complications but resulted in similar rates of deep SSI, readmissions, and re-interventions. Additionally, the number needed to treat to prevent one superficial SSI was 45. They concluded that antibiotics appear effective at reducing SSI after non-emergency cholecystectomy. However, due to the high number needed to treat, it is unclear whether they add a meaningful clinical benefit [27].

A meta-analysis that included 5259 patients [28] showed that antibiotics did not significantly reduce the risk of SSI or overall nosocomial infections. Another double-blinded randomised controlled trial [29] studied the effect of piperacillin/tazobactam (PAP) vs Placebo in acute cholecystitis; the study showed that the postoperative infectious complications (PIC) rate were significantly higher in patients with a raised CRP at randomisation and on the day of surgery and in cases of conversion to an open procedure. Most of the surgeons in this survey use prophylactic antibiotics routinely, despite what one may interpret as a rather limited evidence base in its support.

Gallstone disease is an established risk factor for thromboembolic events [30] The recent NICE guidelines released in 2018 [31] recommend offering VTE prophylaxis to patients undergoing abdominal surgery who are at an increased risk of VTE, starting mechanical VTE prophylaxis on admission until the person no longer has significantly reduced mobility relative to their normal or anticipated mobility, and adding pharmacological VTE prophylaxis for a minimum of 7 days for people undergoing abdominal surgery whose risk of VTE outweighs their risk of bleeding. Interestingly, 69.7%, 45.9%, and 69.4% of the surgeons who took this survey do not routinely offer pharmacological DVT prophylaxis before surgery, elastic compression stockings, or intermittent compression devices, respectively. These may be regarded as alarming figures and perhaps suggest a need for higher quality evidence in this area.

Regarding pneumoperitoneum creation, most of the surgeons preferred the open juxta umbilical technique with more inclination towards the closed technique in patients with obesity. Previous abdominal surgery is associated with increased operative time and adhesions; however, it does not compromise the safety of performing gallbladder surgery. [32] The currently available evidence does not favour one technique over the other for achieving pneumoperitoneum. In this survey, 37.7% (n = 240) of the surgeons use a closed technique in patients with previous abdominal surgery.

Most surgeons preferred to use Liga clips over Hem-o-Loks® when controlling the cystic artery and cystic duct. Unfortunately, there is no study in the literature comparing the two techniques. Studies have also investigated the clipless technique and reported satisfactory outcomes [33, 34].

There is significant variation in practice in the event of an intraoperatively detected bile duct injury. The latest guidelines of the world society of emergency surgery [35] on the surgical management of intraoperatively diagnosed bile duct injury

**Table 3** Qualitative analysis of the free text answers to survey question

| Survey Questions | Percentages (Other Responses)[Ŧ] | Qualitative analysis of free text answers |
|---|---|---|
| Q8—What is your preferred diagnostic modality for patients presenting with obstructive jaundice suspected to be due to gall stone disease? | 7% | The free text answers for this question included the use *of abdominal US followed by CT/MRCP* based on acute vs elective or painless vs painful jaundice |
| Q10—What is your preferred approach for patients with asymptomatic choledocholithiasis diagnosed intraoperatively on a cholangiogram? (keeping in mind patients where all options would be appropriate) | 5.9% | Some surgeons reported the use of *laparoscopic USS* instead of OTC. *Laparoscopic CBD exploration* tans cystic or otherwise; *concomitant ERCP*; and a *trial of ERCP/ CBD exploration* followed by postop ERCP in case of failure are few of the other reported approaches |
| Q14/15—Do you give prophylactic antibiotics? If you don't always give prophylactic antibiotics, how do you decide to give it? (If there is empyema of the gall bladder) | 7.2% & 24% | According to some surgeons the indication for use of antibiotics included certain *patient factors* like immunodeficiency and uncontrolled diabetes; *indication for surgery* like acute cholecystitis; and *certain intraoperative situations* like aspiration of gallbladder/perforation of gall bladder, OTC, CBD exploration or ERCP |
| Q16—Which antibiotic do you recommend for individuals *not allergic to penicillin*? | 26% | First line prophylactic antibiotics included a *single antibiotic* like second generation cephalosporin, tazobactam with piperacillin, gentamicin, ceftriaxone, clindamycin and ciprofloxacin OR *a combination of antibiotics* like metronidazole and gentamicin; metronidazole and doxycycline; metronidazole with amoxicillin; metronidazole with gentamicin and amoxycillin; and metronidazole with ciprofloxacin |
| Q17—Which antibiotic do you recommend for individuals with mild penicillin allergy? | 37% | Some surgeons reported *the use of* vancomycin; clindamycin; tigecycline; teicoplanin; levofloxacin; ceftriaxone; vancomycin with gentamicin; gentamicin and metronidazole; levofloxacin with metronidazole; and gentamicin with metronidazole |
| Q27—What is your preferred (dominant) technique of dissection in Calot's triangle? | 6.9% | Some surgeons used *scissors* with or without bipolar; *ultrasonic device*; *combination* of hook-on diathermy and Maryland; *hydro suction*; and *pledget* for the dissection of Calot's triangle |
| Q28—What is your preferred method for controlling Cystic Artery? | 5.5% | Some of the preferred methods included *tie* in case of financial constrains; *titanium clips*; *diathermy on hook*; *PDS clips*; and sealing with *harmonic device* |
| Q30—How do you approach a difficult Calot's triangle? | 9.9% | Other opinions include *suction cannula*; transection of gall bladder at *Hartman's pouch*; *trans infundibular approach*; *conversion* to open; abandoning the procedure and *referral to specialist centre*; dissection along the *cystic plate* without gallbladder transection followed by retrograde dissection; and combination of all of above techniques |
| Q31—How do you approach a Hartmann's pouch densely adherent to common hepatic/ common bile duct? | 11.3% | *As above* |
| Q37—How do you deal with CBD injury detected intraoperatively? | 12.8% | Surgeons reported that the decision would be *guided by factors like* grade of injury, type of injury (thermal vs Non thermal) and size of duct. Few surgeons will manage this challenging situation by calling a *HPB colleague* in a tertiary care centre setting; a *trial of repair*, conversion to open, placement of drain, and post op ERCP with stenting; or *intraoperative ERCP and stenting* |
| Q48—How long do you give antibiotics for patients with cholecystitis after surgery? | 5% | Some of the surgeons based their decision on *intraop findings* like gallbladder perforation, empyema and gangrene; *biochemical makers* like CRP; and *duration of drain* in situ. One of the surgeons reported *ten days of antibiotics* course in patients with cholecystitis |

**Table 3** (continued)

| Survey Questions | Percentages (Other Responses)[T] | Qualitative analysis of free text answers |
|---|---|---|
| Q49—Do you have any other thoughts regarding this survey? | | This was the most populated section. Few suggestions for improvement in the study included the addition of questions related to role of *resources on practices*; level of *experience of surgeons*; experience of *open cholecystectomy*; *concomitant procedures* with laparoscopic cholecystectomy like lap hernia, and lap sleeve gastrectomy; *positioning* of the patient; *skin incisions*; *single port* cholecystectomy; *hidden 3 ports technique*; *type of camera* (0 vs 30 degree/5 mm vs 10 mm); *TAP block*; dissection using *harmonic* devices; *dealing with complicated situations* like right hepatic artery anatomical variations, gallbladder adherent to the colon, cholecystoduodenal fistulae, Mirrizzi's syndrome and suspected malignancy; surgeons views' on *critical view of safety* (CVS); use of *ICG* and *laparoscopic ultrasonography* (US); approaches to *CBD exploration*; dealing with *bleeding from liver bed*; *subtotal-cholecystectomy rate*; $CO_2$ *removal* practices; *port site hernia* incidence; *dealing with residual stones*; and follow up for *histology* results. *Notably, one of the surgeons complained that Sri Lanka was not in the country list* |

[T]Only questions with free text response by ≥ 5% respondents were included for the thematic analysis

(BDIs) recommend the selective use of adjuncts for biliary tract visualisation (e.g., IOC, ICG-C) during difficult cholecystectomies or whenever BDI is suspected to increase the rate of intraoperative diagnosis and to consider the opinion of another surgeon. They also recommend direct repair with or without T-tube placement in cases of minor BDIs, and hepaticojejunostomy as the treatment of choice in those with major BDIs. Similar recommendations have been proposed by Brunt ML et al. based on their recent survey directed by a steering group and subject experts from well-known surgical societies [36, 37].

When surgeons were asked whether they would use a retrieval bag to retrieve the dissected gallbladder from the abdomen, only about 70% said they would use one. A recent meta-analysis showed no difference in wound infection with the use of a retrieval bag. However, the evidence used was of a low level, so it remains debatable. But most surgeons prefer to use them [38]. Furthermore, only about 69% (n = 428/617) of those who used the retrieval bags confirmed that it was in their operating count. About 61% would retrieve the gallbladder through the umbilical port site, and 37% would retrieve it from the epigastric port. A meta-analysis has shown that retrieval of the gallbladder through the juxta-umbilical port site is associated with less postoperative pain and less retrieval time intraoperatively [39].

Multimodal analgesia is an integral part of the enhanced recovery pathways after abdominal and gastrointestinal surgery. The current evidence suggests the effectiveness of local anaesthetic wound infiltration [40–42]. This study showed variation in practice in this area. Moreover, the majority do not use a local anaesthetic in the gallbladder bed/intra-abdominally. Vijayaraghavalu et al. found that intraperitoneal bupivacaine resulted in a significant reduction in postoperative pain for the first six hours after laparoscopic cholecystectomy, prolonged the time taken to request rescue analgesia, and lessened shoulder pain significantly [43].

Most of the surgeons (86.8%, n = 551/635) in this study do not routinely place a drain. This is probably because there is no evidence to support the use of routine drainage after non-complicated cholecystectomy [44]. Half of the surgeons (n = 319) who participated in this survey would discharge their patients the next day, while around 44% would discharge them on the same day. Day case procedures are of significant financial and psychological benefits, are feasible, and don't compromise patient safety [45]. Around 65% of our participants would still offer a follow-up appointment for their patients.

## Strengths and weaknesses

This is the first global study reporting on variations in a range of pre, peri, and postoperative practices concerning laparoscopic cholecystectomy. Its global reach and large

sample size further suggest that we have captured all common variations. Authors would recommend caution in interpreting commonest variations as best practices as determining best practices for each of these areas is likely to need focussed studies.

At the same time, one can only place limited value on such a set of self-reported data. Choices selected may vary depending on the respondents' engagement with the survey tool, item similarity, and familiarity with the English language. Moreover, we have simply presented the proportions without attempting any complex statistical analyses because the purpose of this study was to understand all the variations in practice rather than carry out a detailed subset analysis for a number of factors. Finally, due to limited numbers from different countries, we have not been able to compare practices according to countries or regions. Our findings need confirmation in future studies.

## Conclusion

This survey is the first study in scientific literature capturing variations in preoperative, perioperative, and postoperative practices concerning Laparoscopic Cholecystectomy. It should pave way for future studies aimed at determining best practices amongst those in use.

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**Data availability** The data used to support the findings of this study can be released upon request.

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**Informed consent** Informed Consent does not apply.

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**Research involving human and/or animal rights** Not Applicable.

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