Case Report

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Is a zero biliary injury rate possible in laparoscopic cholecystectomy?

Abstract

Background: Laparoscopic cholecystectomy is the most common digestive laparoscopic procedure being performed worldwide. Yet, even surgeons who have received training in laparoscopy during their residency report a higher incidence of bile duct injury during laparoscopic surgery than incidence reported during the open surgery era. We analysed a large series of laparoscopic cholecystectomy for all clinical presentations and attempted to classify the problems that surgeons can encounter in different clinical scenarios while performing laparoscopic cholecystectomy and the technical skills they have to learn in order to safely accomplish their surgery in various situations.

Methods: A retrospective analysis of all cases posted for laparoscopic cholecystectomy on an intention-to-treat basis between 2006 and 2014 was carried out. Any variation from standard technique was noted and the cause necessitating this variation was also noted.

Results: A total of 4115 consecutive patients underwent laparoscopic cholecystectomy, in 27.5% of which some modification was added to the standard technique to allow successful completion of the procedure. The mean duration of surgery was 49 minutes and the mean post-operative stay was 2.4 days. The specific problems encountered were 'frozen' Calot's triangle (17.8%), post-operative adhesions (2.6%), pregnancy (1.2%), morbid obesity (9.9%), acutely inflamed distended gallbladder (9.8%), short or absent cystic duct (2.4%), right hepatic artery with 'caterpillar' hump (1%), portal hypertension (8.2%), abnormal anatomy of cystic argery (0.6%), abnormal anatomy of gallbladder (0.2%), empyema of the gallbladder (8.9%), mucocele (4.8%), gangrenous cholecystits (2.5%), sclereoatrophic cholecystitis (0.4%); pancreatic phlegmon following acute biliary pancreatitis (2.2%). The different maneuvers adopted to deal with these variations have been systematically analysed. There were no conversions to open or bile duct injuries. The 30-day mortality was 0.06%.

Conclusion: It is feasible to carry out a large series of laparoscopic cholecystectomies without major morbidity or mortality provided the surgeon is adequately trained in not only the basic steps of the procedure but also the various maneuvers needed to deal with the varied clinical situations encountered in practice.

Volume 7 Issue 6 - 2017

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Received: September 09, 2016 | **Published:** November 06, 2017

Introduction

The laparoscopic revolution is arguably the greatest event in the history of surgery since the discovery of anesthesia. Laparoscopic cholecystectomy is the torchbearer of this surgical revolution. It is one of the commonest surgeries being performed by general surgeons today.[1,2] Since its introduction in the late 80s, it has dramatically affected the management of gallstones and has become the gold standard in the management of symptomatic gallstones.[3-6] This sudden introduction of a new technique of performing surgery and its rapid rise in popularity created issues of training and skills acquisition.[7]

Moreover, as the popularity of laparoscopic cholecystectomy has grown, there has been a broadening of indications. Several conditions like acute cholecystitis, pregnancy and obesity are now no longer considered as contraindication to the laparoscopic approach. With increasing number of laparoscopic cholecystectomies being performed, there was also a spurt in the incidence of iatrogenic biliary injuries.[2] Though initially attributed to the effect of the 'learning curve', it was found that even for experienced laparoscopic surgeons, the biliary injury rate remained higher than for open cholecystectomies.[8]

Our aim is to systematically evaluate and analyze the spectrum of laparoscopic cholecystectomies that has to be performed in the current clinical scenario. By carrying out this exercise, we aim to define the problems that can result in sub-optimal results should the surgeon have been trained only in the techniques required for a standard laparoscopic cholecystectomy. We also aim to systematically categorize all the variants and modifications that have to be adopted to achieve a safe outcome and successful completion of laparoscopic cholecystectomy.

Methods

All the consecutive patients who were scheduled for laparoscopic cholecystectomy (intention to treat) between September 2006 and March 2016 were retrospectively studied. Patients unfit for general anesthesia and hence, laparoscopic surgery, were excluded. Laparoscopic surgeries primarily for other indication in which a cholecystectomy was added, e.g., alongwith a sleeve gastrectomy, were also excluded. A standard laparoscopic cholecystectomy (SLC) was performed using four ports in a supine patient placed in reverse Trendelenberg position with a slight left lateral tilt. The North American approach with the four port technique described by Reddick and Olsen was adopted.[9,10] Minor adhesions due to inflammation or congenital adhesions were lysed with diathermy or ultracision. Any deviation from SLC was labeled as Modified Laparoscopic Cholecystectomy (MLC). Our routine practice is to start liquids orally 4 hours after the surgery and soft diet after 8 hours. Patients are

discharged as soon as they are comfortable and independent in their day to day activities. The data was analyzed to determine whether SLC or MLC was performed, the problems encountered during surgery, the maneuvers performed to overcome these problems and the outcomes. The statistical software used was SPSS ver. 11.0 (IBM Corporation, USA). All the surgeries were performed by a single surgeon formally trained in advanced laparoscopic procedures.

Results

A total of 4115 consecutive patients, consisting of 1901 (46.2%) males and 2214 (53.8%) females, in whom extirpation of the gallbladder was indicated, were posted for laparoscopic cholecystectomy. The mean age of the patient was 48.1 years (range: 4-91 years, Standard Deviation (SD) = 15.24). A standard laparoscopic cholecystectomy (SLC) was performed in 2983 patients (72.5%) while 1132 (27.5%) had some modification added to their procedure (MLC). The mean duration of surgery was 49 minutes (range: 18-158 minutes). However, when stratified according to the type of LC, mean duration of surgery for SLC was 36 minutes (range: 18-75 minutes) and for MLC, it was 57 minutes (range: 22-165 minutes). Using the Mann-Whitney test, this difference was found to be highly significant at p=0.001. The mean post-operative stay was 2.4 days (range: 1-16 days). The mean post operative stay in the SLC group was 1.9 days and in the MLC group was 2.8 days. This difference was not significant at p = 0.05.

Table 1 details the reasons which caused difficulty in access to the hepatocystic triangle. Problems causing technical difficulties in performing LC occurred in 22.6% of the patients (Table 2), of which the commonest was the presence of a distended gallbladder (9.8%) due to acute inflammation. Since the cystic artery and duct were dissected and clipped as close to the gallbladder as possible, no attempt was made to identify any anatomic anomalies except those that hindered in the aforementioned areas. Thus a right superficial or posterior sectoral duct opening into the junction of the cystic duct and gallbladder was dissected and clipped (since it was less than 2 mm in diameter) and cystic arteries crossing the duct from caudally and anteriorly had to be carefully dissected and clipped. Gall bladder anomalies in the form of a Phrygian cap deformity of the gallbladder and an accessory posterior sectoral duct opening into the gallbladder neck were seen in a total of 6 patients. Problems due to specific pathology were encountered in 18.8% of cases (Table 3).

Table 1 Difficulty in Access to the Hepatocystic Triangle

Reason	N	%
'Frozen' Calot's triangle	733	17.8
Post-Op Adhesions	107	2.6
Pregnancy	49	1.2
Morbid Obesity	407	9.9
Total	1296	31.5

Table 2 Reasons for technical difficulties in performance of LC

Reason	N	%
Distended acutely inflamed gallbladder	305	9.8
Short & wide/absent cystic duct	75	2.4
Right hepatic artery caterpillar hump	31	1
Cirrhosis with portal hypertension	255	8.2
Abnormal anatomy of cystic artery	19	0.6
Abnormal anatomy of gallbladder	6	0.2
Total	704	22.6

Table 3 Difficulty due to specific pathological conditions

Reason	N	%
Empyema of the gallbladder	365	8.9
Mucocele	198	4.8
Gangrenous cholecystitis	103	2.5
Scleroatrophic gallbladder	17	0.4
Pancreatic phlegmon	91	2.2
Total	774	18.8

The various maneuvers adopted to deal with these conditions are detailed in Table 4. Laparoscopic Subtotal Cholecystectomy (LSC) was performed in 24.9% of patients. This adaptation and its 3 variants – LSC I, LSC II and LSC III – have been described previously.[11] In brief, in LSC I, after transaction of the cystic duct and artery, the gallbladder is not peeled from the liver bed but is transected around its posterior wall which is left intact on the liver bed. The mucosa of the posterior wall of gall bladder is either peeled off or fulgurated with electrocautery. In LSC II, the gallbladder is divided at its neck as close medially as possible safely. If required, after initially opening up the neck of the gallbladder, a further cuff of gallbladder is excised guided by the internal opening of the cystic duct and the medial remnant (which should be less than 1 cm.) is sutured close with polyglactin 2-0 continuous interlocking sutures after fulgurating the mucosa. LSC III is essentially a combination of LSC I & II. Extra ports were required to put in place a fan blade retractor to depress the pancreatic head or bulky omentum in cases of resolving pancreatitis or morbid obesity respectively. A short wide cystic duct or absent cystic duct was encountered in 2.4% of cases and required suturing with 2-0 polyglactin.

Table 4 Maneuvers adopted

Modification	N	%
LSC	1025	24.9
LSC I	8	0.2
LSC II	704	17.1
LSC III	313	7.6
Extra port(s)	222	5.4
Gallbladder decompression	1017	24.7
Intraoperative cholangiogram	17	0.4
Cystic duct looped	4	0.1
Cystic duct sutured	74	1.8
Retrograde approach	4	0.1
Conversion	0	0

Table 5 Intra-Operative & Early Post-Operative Complications

Morbidity	N	%
Cystic artery avulsion and hemorrhage	12	0.3
Bleeding from gallbladder bed	4	0.1
Pulmonary edema	4	0.1
Paralytic ileus	4	0.1
Superficial wound infection	119	2.9
Analgesic need > 1 week	457	11.1
Prolonged bilious drainage	189	4.6
Retained CBD stone	3	0.06
Bilioma	3	0.06
30-day mortality	3	0.06
Overall	798	19.4

Citation: Jani K, Shah A. Is a zero biliary injury rate possible in laparoscopic cholecystectomy? *Gastroenterol Hepatol Open Access.* 2017;7(6):358–361. DOI: 10.15406/ghoa.2017.07.00261

The intra-operative and early post-operative complications are summarized in Table 5. We rarely perform intra-operative cholangiogram (0.4%) or the retrograde approach (0.1%). In cases where LSC II has been performed in acute severe cholecystitis, we place a 28G drain in the Morrison's pouch. As the edema decreases, the sutures may loosen and the drain carries out any bile that leaks. Prolonged biliary drainage lasting more than 2 days was encountered in 4.6% of patients but no further intervention was required. The bile in drain typically appears after 72-96 hours of surgery. Removal of the tube prior to this as it was not draining anything leads to bilioma which then has to be drained by percutaneous placement of ultrasonographically guided pigtail catheters, which occurred in 2 of our early cases. Subsequently, in such cases we remove the drain not before the 5th post-operative day, if it is not draining anything. We had two mortalities, one due to pulmonary collapse due to severe bronchorrhea on the 8th post-operative day and the other was a sudden cardiac arrest on the 3rd post-operative day, possibly due to a thromboembolic event.

Discussion

Laparoscopy has made an indelible impact on the way surgeons practice their art. The minimally invasive approach afforded by it confers several benefits on the patients, including decreased pain, shorter hospital stay and earlier return to normal activities.[12-14] Four years after its introduction in the United States, more than 80% of US surgeons were performing laparoscopic cholecystectomy.[3] At the same time, the reported incidence of bile duct injuries increased with the increasing rates of laparoscopic cholecystectomy.[2,15–18] This was attributed to the phenomenon of the "learning curve".[13]

The apprenticeship model, wherein registrars are part of a structured training program with a stepwise progression of skills acquisition, under the supervision of consultants, with regular audit appears to be the most rational manner of imparting training in laparoscopic surgery.[19,20] It has been shown that surgeons who have been trained in laparoscopic techniques during their residencies do have a lower incidence of bile duct injuries associated with laparoscopic cholecystectomy.[2,21–23] Importantly, laparoscopic training during surgical residency reduces the learning curve associated morbidity, thus allowing the surgeons to acquire the skills and experience in laparoscopic techniques while avoiding the pitfalls that trapped surgeons who had started performing laparoscopic surgery after training through post-graduate courses alone.[2] However, what is surprising is that even after the "learning curve" is over, bile duct injuries still occur with laparoscopic cholecystectomy two to three times more frequently than with open cholecystectomy and this rate is persisting and not reducing even as the experience of the surgeons increases.[24–27] A survey of surgeons who experienced bile duct injury during LC revealed that in the majority of cases, there was a preoperative diagnosis of acute cholecystitis or the case was being performed in emergency settings or at night or the surgeon encountered a short or abnormal cystic duct.1 Acutely distended gallbladder was encountered in 26.1% of cases of our series.

In 4.8% cases, it was non-inflammatory due to a long-standing calculi getting impacted in the neck of the gallbladder or the cystic duct, resulting into a mucocele of the gallbladder. In the remaining 21.3% of cases, acute cholecystitis, including its extreme manifestations like empyema and gangrene were responsible for the distension. Attempt to dissect out the cystic duct and artery in such a setting would be more likely to lead to inadvertent injury to the biliary ducts or the vessels.[1,28] Decompression of the gallbladder be inserting the midclavicular trocar-canula into it and applying suction at the beginning of the procedure greatly eases the procedure by aiding in retraction of the gallbladder as well as opening up the Calot's triangle. While this may seem self-evident, we have seen surgeons trying futilely to retract a distended gallbladder or struggling in medial dissection as an engorged neck obliterates the triangle or attempting to decompress a gallbladder filled with viscid secretions or thick pus using a transcutaneously placed lumbar puncture needle. In severe acute cholecystitis, the entire medial aspect is indurated, highly vascular and the anatomy is obliterated, the so-called 'frozen' Calot's triangle. Persistent attempts at dissection in this area are prone to bleeding and, coupled with injudicious use of energy sources, biliary injuries.[28] In such cases, if initial dissection with a blunt suction canula does not seem to yield any results, we open the gallbladder at the neck or the medial most identifiable portion of the gallbladder. The inner opening of the cystic duct then serves as a guide and after excising, if required, a further cuff of the neck, we perform LSC II.

Together, the techniques of safe adhesiolysis and LSC II can take care of the major cause underlying bile duct injuries, viz. acute inflammatory changes, which accounted for 44% of the bile duct injuries in Francouer's study.1 Portal hypertension with or without cirrhosis carries two dangers. If it is due to extra-hepatic portal vein obstruction, there is likely to be a cavernomatous malformation of the portal vein, wherein, instead of a single venous channel, one is likely to encounter multiple high pressure venous channels carrying blood to the liver. Any dissection in the Calot's triangle area can damage one or more of these channels and cause torrential hemorrhage. Additionally, if the underlying pathology is cirrhosis of the liver, the gallbladder bed is prone to have large portal venous tributaries which are prone to hemorrhage while attempting to separate the gallbladder from the liver. In these situations, we perform LSC I or III as the situation warrants. One of the most dangerous conditions that we have encountered is scleratrophic cholecystitis or 'thimble' gallbladder. The patient typically is a diabetic with history of recurrent attacks of cholecystitis spanning several years. At the time of surgery, there is dense fibrosis in the gallbladder area with the duodenum, distal stomach, transverse colon and omentum firmly adherent to the undersurface of right liver. After careful adhesiolysis, the gallbladder which has been reduced by repeated inflammatory attacks to the size of the distal phalanx of the thumb (hence the sobriquet of 'thimble' gallbladder) is difficult to identify, the difficulty compounded by the fact that often there is hardly any discrepancy in size of the gall bladder and the common bile duct. Moreover, due to fibrosis, the common bile duct is pulled laterally and, if one is not careful, is easily mistaken for cystic duct, or part of the gallbladder and injured. Awareness of this clinical entity, suspecting its presence in the patients presenting for surgery after a history of suffering from pain and dyspepsia over several years and not months and using the Rouviere's sulcus as a guide to the plane of the common bile duct has allowed us to successfully deal with 11 such cases.

This has been the first systematic attempt to quantify and specify the set of skills and techniques that a surgeon needs to learn to perform laparoscopic cholecystectomy in a variety of clinical situations safely. We have ennumerated seven manuevers listed in Table 4 which should be there in the armamentarium of every surgeon to enable him/her to successfully deal with all variations of gall bladder presentation. There may be presence of more than one 'difficulty' in the same patient, requiring adoption of more than one maneuver.

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Conclusion

It is possible to perform a large series of laparoscopic cholecystectomies without encountering major biliary injury (biliary injuries requiring re-intervention, either endoscopic or surgical). Of additional skill sets required, we found that proficiency in intracorporeal suturing, early decompression of distended gallbladder, performance of subtotal cholecystectomies and its variants coupled with a thorough knowledge and familiarity with the variable anatomy of the hepatocystic region can lead one to execute a safe laparoscopic cholecystectomy in all its clinical manifestations.

Conflicts of interest

None.

Acknowledgements

None.

Funding

None.

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Citation: Jani K, Shah A. Is a zero biliary injury rate possible in laparoscopic cholecystectomy? *Gastroenterol Hepatol Open Access.* 2017;7(6):358–361. DOI: 10.15406/ghoa.2017.07.00261