

Blunt Dissection: A Solution to Prevent Bile Duct Injury in Laparoscopic Cholecystectomy

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Abstract

Background: Laparoscopic cholecystectomy (LC) has been a standard operation and replaced the open cholecystectomy (OC) rapidly because the technique resulted in less pain, smaller incision, and faster recovery. This study was to evaluate the value of blunt dissection in preventing bile duct injury (BDI) in laparoscopic cholecystectomy (LC).

Methods: From 2003 to 2015, LC was performed on 21,497 patients, 7470 males and 14,027 females, age 50.3 years (14–84 years). The Calot's triangle was bluntly dissected and each duct in Calot's triangle was identified before transecting the cystic duct.

Results: Two hundred and thirty-nine patients (1.1%) were converted to open procedures. The postoperative hospital stay was 2.1 (0–158) days, and cases (46%) had hospitalization days of 1 day or less, and 92.8% had hospitalization days of 3 days or less; BDI was occurred in 20 cases (0.09%) including 6 cases of common BDI, 2 cases of common hepatic duct injury, 1 case of right hepatic duct injury, 1 case of accessory right hepatic duct, 1 case of aberrant BDI 1 case of biliary stricture, 1 case of biliary duct perforation, 3 cases of hemobilia, and 4 cases of bile leakage.

Conclusion: Exposing Calot's triangle by blunt dissection in laparoscopic cholecystectomy could prevent intraoperative BDI.

Key words: Bile Duct Injury; Blunt Dissection; Laparoscopic Cholecystectomy

INTRODUCTION

Laparoscopic cholecystectomy (LC) has been a standard operation and replaced the open cholecystectomy (OC) rapidly because the technique resulted in less pain, smaller incision, and faster recovery. From 1987, in which year Mouret performed the first LC, the new technique developed fast.^[1] Despite the benefits of LC, there is still concern about some severe complications of this technique, especially bile duct injury (BDI). In order to reduce BDI, surgeons must expose Calot's triangle clearly without a sense of touch in LC. Now, there are two techniques universally used in LC. One is energized dissection, such as electric coagulation, monopolar electrosurgery, and ultrasonic scalpel. The other one is cold dissection, including sharp dissection, and blunt dissection.

Based on some reports of multicenter, large-sample trial studies, the rate of BDI in LC was 0.10–0.42%^[2] around the world. Our center firstly used blunt dissection by flushing and aspiration to expose Calot's triangle and had a satisfactory result. From 2003 to 2015, LC was performed on 21,497 patients in 12 years. The Calot's triangle was exposed by blunt dissection routinely before transecting the cystic duct. Above all cases, BDI was diagnosed in 20 patients (0.09%).

In this study, we were to introduce the technique of blunt dissection and to show the BDI cases in our institution.

METHODS

Patient

From 2003 to 2015, 21,497 LCs were performed in Department of General Surgery, Sir Run Run Shaw Hospital of Zhejiang University. There were 7470 males and 14,027 females, aged 50.3 years (14–84 years). In all the cases, 19,343 patients were diagnosed as cholecystolithiasis, including 16,754 chronic cholecystolithiasis and 2589 acute cholecystolithiasis; 2154 patients were diagnosed as cholecystic polypus. Informed consent was not required because of the retrospective nature of this study.

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Received: 20-08-2015 **Edited by:** Yi Cui

How to cite this article: Cai XJ, Ying HN, Yu H, Liang X, Wang YF, Jiang WB, Li JB, Ji L. Blunt Dissection: A Solution to Prevent Bile Duct Injury in Laparoscopic Cholecystectomy. Chin Med J 2015;128:3153-7.

Access this article online

Quick Response Code:



Website:
www.cmj.org

DOI:
10.4103/0366-6999.170270

Operation

The operations were performed under general anesthesia. The technique of blunt dissection with flushing and aspiration was used in each operation to expose Calot's triangle. Patients were placed in supine position and 4 entries (1 umbilical, 1 epigastric, and 2 in the right flank) were made. A Veress needle was inserted directly under the umbilicus to allow for the flow of carbon dioxide into the peritoneal cavity, and the pneumoperitoneum was established at 12–14 mmHg. The cystic artery and cystic duct were ligated with clips after the cystic duct, the common hepatic duct, and the common hepatic duct were identified [Figure 1].

Prophylactic antibiotics were used in all operated patients (half an hour before surgery, intravenously). In cases of conversion from LC to OC, the preferred incision was a subcostal incision.

Laparoscopic cholecystitis grading

As inflammation around the gallbladder, the laparoscopic cholecystitis grading (LCG) was classified into four grades (G0–G3) [Table 1].^[3]

Type of bile duct injury

The Strasberg classification^[4] was used to describe the type of BDI (based on surgical and cholangiographic findings) and the Dindo-Clavien classification^[5] was used to stratify the severity of complications [Tables 2 and 3].

Data of patients

Patient demographics include age and gender; operation time, rate of conversion, surgeon; the hospitalization days, complications, and types and treatments of BDI.

RESULTS

During the 12-year study period, 21,497 LCs were performed by blunt dissection with flushing and aspiration, operation time 45 (range: 20–300 minutes) minutes, average bleeding 14 ml. Mean hospitalization days were 2.1 days, and about 46% had hospitalization days of 1 day or less. 92.8% had hospitalization days of 3 days or less. Two hundred and thirty-nine cases had conversion because of severe adhesion, carcinoma of the gallbladder, gallbladder-intestine fistula, and BDI. Twenty patients had diagnosis of BDI, representing

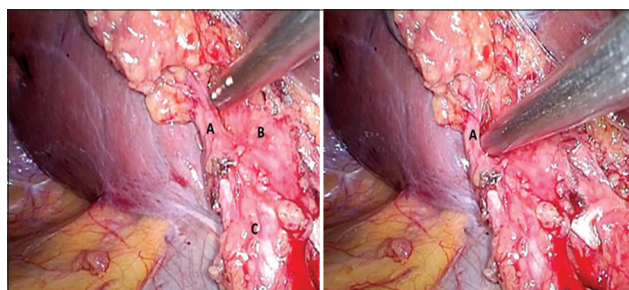


Figure 1: Exposure of Calot's triangle by blunt dissection with flushing and aspiration. The main equipment of the technique is laparoscopic suction and irrigation tubes. In the picture, we identified the cystic duct (A), the common hepatic duct (B) and the common hepatic duct (C).

an incidence of 0.09%. In 11 cases (55%), the diagnosis was performed during the surgical procedure. The other 9 patients were diagnosed BDI after the operation.

Patients of bile duct injury

Twenty patients were diagnosed BDI, 14 males and 6 females. Three patients were acute cholecystolithiasis, and 17 patients were chronic cholecystolithiasis. Based on the LCG, there were 8 G1, 7 G2, and 5 G3. The operating surgeon was a senior HPB staff in 17 cases (85%), an HPB

Table 1: Laparoscopic cholecystitis grading

Grade	Description
0	Mild adhesion without inflammation of the gallbladder
1	Inflammatory fibrous adhesion without acute inflammation
2	Severe inflammatory thickening of the gallbladder with mild adhesion
3	Lack of visualization of the gallbladder due to close inflammatory adhesion

Table 2: Type of bile duct injury

Type	Description
A	Cystic duct leaks or leakage from aberrant
B	An injury of aberrant right duct
C	A bile leak from a major aberrant right duct without an injured common duct
D	A lateral injury to the extrahepatic common duct
E	Bile duct strictures E1 – E5
E1	A circumferential injury to the common duct >2 cm from the bifurcation
E2	A circumferential injury to the common duct <2 cm from the bifurcation
E3	A circumferential injury to the common duct at the bifurcation
E4	An injury proximal to the bifurcation involving both main right and left hepatic ducts
E5	A combined injury to the common duct and a major aberrant right hepatic duct

Table 3: The Dindo-Clavien classification

Type	Description
Grade 1	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions
Grade 2	Requiring pharmacological treatment with drugs other than such allowed for Grade 1 complications. Blood transfusions and total parenteral nutrition are also included
Grade 3	Requiring surgical, endoscopic, or radiological intervention
Grade 3a:	Intervention not under general anesthesia
Grade 3b:	Intervention under general anesthesia
Grade 4	Life-threatening complication (including CNS complications) requiring IC/ICU management
Grade 4a:	Single organ dysfunction (including dialysis)
Grade 4b:	Multiorgan dysfunction
Grade 5	Death of patient

CNS: Central nervous system; IC: Intermediate care; ICU: Intensive care unit.

surgery fellow in 2 cases (10%), and a general surgery resident in 1 case (5%). The BDIs in these 20 cases were as follows: 6 cases of common BDI (4 cases of lateral injury and 2 circumferential injury), 2 of common hepatic duct injury, 1 of right hepatic duct injury, 1 of accessory right hepatic duct, 1 of aberrant BDI, 1 of biliary stricture, 1 of biliary duct perforation, 3 of hemobilia, and 4 of bile leakage. One case of right hepatic duct injury and 1 case of common hepatic duct injury were caused by thermal damage of electric coagulation. According to Strasberg-Bismuth Classification of BDI, there were 4 type A (20%), 1 type B (5%), 1 type C (5%), 10 type D (50%), and 1 type E2 (5%). The other 3 cases suffered in bile duct bleeding [Table 4].

Management and repair

The LCs were converted to open in 10 cases (50%). Laparoscopic BDI repair was performed in 1 patient (5%). Two cases were diagnosed BDI after operations and received second surgeries. Seven cases were diagnosed BDI after operations and had conservative treatment. Above the 20 cases, 17 cases (85%) were selective operations (8 cases [47%] were converted to repair BDI, 2 cases received second surgeries) and 3 cases were emergency operations (2 cases [67%] were converted to repair BDI).

Ten cases were converted to open surgery (6 cases of common BDI, 2 of common hepatic duct injury, 1 of right hepatic duct injury, and 1 of accessory right hepatic duct). The most common procedure performed was a primary closure in 8 with T-tube placement, and 2 Roux-en-Y hepaticojejunostomies (2 with a circumferential injury of

the common bile duct). In 1 case (aberrant BDI), the injury was repaired laparoscopically.

Nine cases were diagnosed after operations. Two cases (1 biliary duct perforation and 1 bile leakage) received the second surgery: 1 case of biliary duct perforation was performed Roux-en-Y hepaticojejunostomy and stayed in Intensive Care Unit (ICU) for more than 2 weeks; 1 case of bile leakage was performed peritoneal lavage and drainage. One patient had jaundice after surgery and was diagnosed biliary stricture by magnetic resonance cholangiopancreatography. This patient received conservative treatment and achieved remission of symptoms in 1 week. The other 6 cases (3 bile duct bleeding and 3 bile leakage) also had conservative treatment with ultrasound guided percutaneous puncture catheter drainage and achieved remission of symptoms [Tables 4 and 5].

Outcomes

The outcomes of BDI managed are summarized in Tables 1 and 2. There was no death in 20 cases, and all the patients recovered well. Twelve cases (60%) were grade II and 6 cases (30%) of leakage or bleeding required ultrasound guided percutaneous puncture catheter drainage (grade IIIa). Common bile duct perforation with bile leakage developed in 1 case (IV b), which received the second surgery to do Roux-en-Y hepaticojejunostomies and stayed in ICU for more than 1 month because of multiorgan dysfunction. The other one had a bile leakage with severe infection and received the second surgery to lavage and drainage (IIIb). Mean hospitalization days was 21 days (range: 5–158 days), and all the patients were fully recovered.

Table 4: Operative data and overall perioperative outcomes in patients with BDI after LC

Patient Number	LCG	Time	Type of BDI	Convert	Surgeon level	Management	Complication	Hospital stay (days)	Outcomes
1	Grade 2	Selective	Right hepatic duct	Yes	Senior	Primary closure + T-tube	II	28	Recovery
2	Grade 2	Selective	Aberrant bile duct	Yes	Senior	Primary closure	II	7	Recovery
3	Grade 3	Selective	Partial CBD	No	Senior	Primary closure + T-tube	II	21	Recovery
4	Grade 1	Selective	Partial CBD	Yes	Senior	Primary closure + T-tube	II	23	Recovery
5	Grade 1	Selective	Partial CBD	Yes	Senior	Primary closure + T-tube	II	30	Recovery
6	Grade 3	Selective	Partial CBD	Yes	Senior	Primary closure + T-tube	II	7	Recovery
7	Grade 3	Emergency	Complete CBD	Yes	Fellow	RYH	II	8	Recovery
8	Grade 2	Selective	Complete CBD	Yes	Senior	RYH	II	17	Recovery
9	Grade 1	Selective	CBD perforation	No, SS	Senior	SS to RYH	IVb	158	Recovery
10	Grade 1	Emergency	CBD stricture	No	Fellow	Conservative treatment	II	5	Recovery
11	Grade 3	Emergency	Partial CHD	Yes	Senior	Primary closure + T-tube	II	8	Recovery
12	Grade 3	Selective	Partial CHD	Yes	Senior	Primary closure + T-tube	II	14	Recovery
13	Grade 2	Selective	Right hepatic duct	Yes	Senior	Primary closure + T-tube	II	8	Recovery
14	Grade 1	Selective	Bile leakage	No, SS	Senior	SS to lavage and drainage	IIIb	26	Recovery
15	Grade 2	Selective	Bile leakage	No	Senior	Conservative treatment	IIIa	15	Recovery
16	Grade 1	Selective	Bile leakage	No	Resident	Conservative treatment	IIIa	7	Recovery
17	Grade 1	Selective	Bile leakage	No	Senior	Conservative treatment	IIIa	14	Recovery
18	Grade 1	Selective	Bile duct bleeding	No	Senior	Conservative treatment	IIIa	9	Recovery
19	Grade 2	Selective	Bile duct bleeding	No	Senior	Conservative treatment	IIIa	7	Recovery
20	Grade 2	Selective	Bile duct bleeding	No	Senior	Conservative treatment	IIIa	8	Recovery

CHD: Common hepatic duct; CBD: Common bile duct; BDI: Bile duct injury; LCG: Laparoscopic cholecystitis grading; LC: Laparoscopic cholecystectomy; SS: Secondary surgery; RYH: Roux-en-Y hepaticojejunostomy.

DISCUSSION

BDI is the most severe complication in LC. According to a report, the rate of BDI in LC was 0.10–0.42%,^[3] and common BDI and common hepatic duct injury were the most common types, ranged from 61.0% to 77.5%.^[6–8] Before the adoption of this technique, 14,302 cases of laparoscopic cholecystectomies were performed in our institute by the conventional procedure and the occurrence rate of biliary injury was 0.37%^[9] which was significant higher than that reported in the current study ($P < 0.05$, chi-square analysis), but we did not use this comparison to approve the advantage of the current procedure because of the potential impact of the learning curve. We reviewed large-series reports of LC, which had more than 10,000 cases on PubMed [Table 6]. The occurrence rate of biliary injury in our series is lower than that in these reports that might account for the potential advantage of this procedure. According to these reports, causes of BDI include: (1) severe adhesion, it is difficult to expose Calot's triangle clearly; (2) abnormal anatomy of bile duct; (3) improper operation, such as thermal injury by electric coagulation, monopolar electrosurgery, and ultrasonic scalpel, bile duct stricture caused by clips; (4) surgeons are not trained well.^[10,11]

Agarwal *et al.*^[12] showed an RCT study in 2014, the use of energetic dissection in LC, like electric coagulation and ultrasonic scalpel, was associated with higher risk of complication. McKinley *et al.*^[13] reported that the rate of BDI in surgeon's first LC was 1.7%, but in one's 50th LC the rate reduced to 0.17%. So in LCs, experienced and well-trained surgeons are very important. Besides, the most important measure to avoid BDI was exposing the Calot's triangle clearly.^[14] In conclusion, our center firstly used blunt dissection by flushing and aspiration to expose the Calot's triangle. The technique has two advantages: (1) blunt dissection, which can avoid thermal injury by using energetic dissection and reduce injury by sharp dissection; (2) the equipment is cheap, simple, and easy for young surgeons to learn. Surgeons use laparoscopic suction and irrigation tubes to flush and aspirate the Calot's triangle repeatedly. We collected data of 12-year LCs in our institution. Total 21,497 LCs were performed by blunt dissection with flushing and aspiration. Two hundred and thirty-nine cases (1.1%) were converted to open, 20 cases (0.09%) were BDI and 11 cases of BDI (55%) were diagnosed in operations. Compared with other institution around the world (over 10,000 LCs), we had a significantly lower incidence of BDI in LCs [Table 6]. In the 20 cases, there were 17 senior surgeons, 2 fellows, and 1 resident. Above all, we found that the rate of BDI and converted using our blunt dissection were both less than other large sample trial studies around the world. According to the analysis of surgeons, 85% cases were performed by senior surgeons and only 15% cases were performed by junior surgeons. It proved that this technique was easy for young surgeons to learn and control. So we believed that the technique of blunt dissection with flushing and aspiration is the best and easiest solution for surgeons to expose the Calot's triangle and reduce the incidence of BDI.

Table 5: Type of BDI, repair, and overall results

Characteristics	Results, n (%)
Type of injury	
A	4 (20)
B	1 (5)
C	1 (5)
D	10 (50)
E2	1 (5)
Artery injury	3 (15)
Type of repair	
Primary closure	9 (45)
Second surgery	2 (10)
RYH	2 (10)
Conservative treatment	7 (35)
Complications	
II	12 (60)
IIIa	6 (30)
IIIb	1 (5)
IVb	1 (5)
Hospitalization (days)	
Mean	21
Range	5–158
Mortality	0 (0)
Follow-up	0 (0)

BDI: Bile duct injury. RYH: Roux-en-Y hepaticojejunostomy.

Table 6: Literatures of LC

Year	Author	Patients (n)	BDI incidence (%)
1993	Deziel <i>et al.</i> ^[18]	77,604	0.60
1998	Vecchio <i>et al.</i> ^[19]	114,005	0.49
2005	Wang <i>et al.</i> ^[9]	14,302	0.37
2006	Waage and Nilsson ^[20]	152,776	0.40
2010	Zha <i>et al.</i> ^[21]	13,000	0.28
2011	Harboe <i>et al.</i> ^[10]	20,307	0.20
2013	Pekolj <i>et al.</i> ^[22]	10,123	0.18
2013	Grbas <i>et al.</i> ^[2]	10,317	0.24
2013	Fullum <i>et al.</i> ^[23]	377,424	0.30

BDI: Bile duct injury; LC: Laparoscopic cholecystectomy.

The main equipment of the technique is laparoscopic suction and irrigation tubes. It has three advantages: (1) laparoscopic suction and irrigation tubes are blunt tools and have a high safety in dissection; (2) it is easy for surgeons to control and it can flush and aspirate repeatedly to keep operation field clear without changing equipment frequently; and (3) laparoscopic suction and irrigation tubes are cheap and available equipments, it can reduce the cost of operations.^[15]

The technique of blunt dissection by flushing and aspiration to expose the Calot's triangle is safe and simple. Detailed operation procedures: First step is open a hole in the anterior sheath over the Calot's triangle wall by dissecting forceps, then using laparoscopic suction and irrigation tubes to flush and aspirate the Calot's triangle repeatedly through the anterior sheath hole until we see the cystic duct clearly. Second step is flushing and aspiration in a direction parallel to the cystic duct, from its length down toward the junction

of the cystic duct, common bile duct, and common hepatic duct until exposing the bile duct clearly. Third, in order to expose the cystic artery and abnormal anatomy, we can use the same way to flush and aspirate the tissue in the Calot's triangle and identify all the location of main arteries and bile ducts. If the Calot's triangle cannot be dissected clearly with severe adhesion, in our experience, we cannot cut-off the arteries and bile ducts blindly, and we can use intraoperative cholangiography to locate bile ducts. So we believe that blunt dissection by flushing and aspiration is an effective solution to expose bile ducts and arteries, especially abnormal anatomy.

Besides, based on our experience, there were some notices for prevention of BDI: (1) Check carefully before operations and evaluate the abnormal anatomy; (2) Do not cut-off the ducts before the main bile ducts are not clear; (3) Reduce the use of energetic dissection; (4) Intraoperative cholangiography can show the bile ducts clearly and prevent BDI, but now many experts considered that it is unnecessary for surgeons to perform intraoperative cholangiography in all the LCs.^[16,17]

In conclusion, avoiding BDI is a major issue for surgeons in LC. Blunt dissection by flushing and aspiration to expose Calot's triangle, and results proved it to be a valuable method to avoid BDI.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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