

Triple Duct Sign is Potentially Important Finding in the Prevention of Major Bile Duct Injury during Laparoscopic Cholecystectomy

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ABSTRACT

Background : Despite recent improvements in surgical techniques, bile duct injury (BDI) remains a serious complication during laparoscopic cholecystectomy (LC).

Methods : The medical records of 1,203 patients who underwent LC from 2012 through 2019 were reviewed, and data regarding cases of BDI were extracted. The cases of BDI were then identified, and the surgery videos reviewed. Cases of BDI were defined as “major” if reconstruction was required and as “minor” if treatment was possible with simple closure or an endoscopic approach.

Results : Cases of BDI during LC were identified in 5 (0.41%) of 1,203 patients : 2 of Bismuth-Strasberg type E2, 1 of major D, and 2 of D minor BDI. The cases of type E2 and type D major were identified intraoperatively, after which hepaticojejunostomy was performed. One case of minor BDI was identified intraoperatively and was immediately repaired. The other case of minor BDI, identified 1 day after LC, was successfully treated with endoscopic drainage. Video review showed the triple duct sign in all 3 patients with major BDI, with the cystic duct appearing as 1 duct and the highly retracted common hepatic duct appearing as 2 ducts.

Conclusion : The triple duct sign is a potentially important finding in the prevention of major BDI during LC.

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Key words : bile duct injury, laparoscopic cholecystectomy, triple duct sign

INTRODUCTION

Despite recent improvements in surgical techniques and instruments, bile duct injury (BDI) remains a serious complication of laparoscopic cholecystectomy (LC). A national survey by the Japan Society for Endoscopic Surgery¹ found that BDI due to LC (BDI-LC) was identified in 0.64% of 452,000 patients, with no significant change in the incidence rates from 1990 through 2002 (0.67%) to 2003 through 2013 (0.62%). In other words, the incidence of BDI-LC in Japan has not decreased significantly over the

last 2 decades despite the standardization of surgical techniques and a nationwide spread of this procedure.

Although a key to preventing BDI is reportedly creating a critical view of safety (CVS)², a poor understanding of the relevant anatomy CVS is created might lead to BDI. Therefore, in the present study, we reviewed institutional cases of BDI to examine factors that predict the occurrence of major BDI, defined as cases requiring surgical reconstruction. We examined situations in which major BDI is likely to occur and evaluated its characteristic signs.

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METHODS

The medical records of 1,203 patients who had undergone LC at The Jikei Medical University Hospital from 2012 through 2019 were reviewed. Cases of BDI-LC were classified according to the Bismuth–Strasberg classification system³ (Supplemental Figure). Also reviewed were surgical and nonsurgical treatment of cases of BDI-LC, clinical courses, and patient outcomes. Videos of LC showing BDI were reviewed by 2 surgeons (HS and JY). Cases of BDI were reviewed for patient age and sex, operation time, blood loss with or without intraoperative cholangiography (IOC), postoperative course, and treatment method. The extent to which the anatomy had been misidentified and manipulated with the surgical technique was then reviewed. A medical record review examined the presence of BDI. Videos were subsequently reviewed for the presence of the triple duct sign, which was defined as the cystic duct appearing as 1 duct and the highly retracted common hepatic duct appearing as 2 ducts. The type of BDI was defined as “major” if reconstruction was required and as “minor” if treatment was possible with simple closure or via an endoscopic retrograde biliary drainage approach.

Ethics

This study has been approved by the Ethics Committee of The Jikei University School of Medicine for Biomedical Research (Registration Number : 27-177).

RESULTS

Cases of BDI were identified in 5 (0.41%) of the 1,203

patients who had undergone LC (Table 1), which had been indicated in all 5 patients by acute cholecystitis. The median operative time in these 5 patients was 152.5 minutes (range, 134–560 minutes), and the median volume of blood loss was 314 g (range, 5–920 g). The cases of BDI were Bismuth–Strasberg type E2 major in 2 patients, type D major in 1 patient, and type D minor in 2 patients (Fig. 1). The cases of BDI of type E2 and type D major were identified during LC, and the 2 patients underwent IOC followed by immediate Roux-en-Y hepaticojejunostomy. Of the cases of type D minor BDI, 1 was identified during LC and was immediately and successfully primary closure. The other case of type D minor BDI was identified 1 day after LC, had been caused by local biliary peritonitis, and was successfully treated with endoscopic drainage. A review of videos revealed the triple duct sign in all 3 patients with major BDI (Fig. 2).

All 5 patients with BDI recovered and were discharged from the hospital by 14 days with no sign of cholangitis, icterus, or surgical-site infection. However, the patient in case 3 treated with hepaticojejunostomy had biliary stricture and underwent revision surgery 6 months later.

DISCUSSION

Although creation of the CVS is considered the key step for BDI prevention during LC⁴, we found that the common hepatic duct may be highly retracted toward the gallbladder owing to severe inflammation during LC for acute cholecystitis. During LC in patients without inflammation at Calot’s triangle, 2 ducts (i.e., the cystic artery and the cystic duct) can be identified in the surgical field. The triple duct

Table 1. Cases of bile duct injury during laparoscopic cholecystectomy at The Jikei University Hospital

Case	Year	Patient age (years)	Patient sex	IOC for diagnosis	BDI type*	Intraoperative repair	Repair procedure	Triple duct sign	Drainage	PO stay (days)
1	2012	72	F	yes	E2 major	yes	RYH	yes	ERBD	13
2	2013	54	M	yes	E2 major	yes	RYH	yes	PTGBD	14
3	2015	54	M	no	D major	yes	RYH	yes	PTGBD	7
4	2013	44	F	no	D minor	yes	primary closure	no	no	10
5	2015	53	M	no	D minor	no	ERBD (PO day 1)	no	no	10

F, female ; M, male ; BDI, bile duct injury ; IOC, intraoperative cholangiography ; PO, postoperative ; RYH, Roux-en-Y hepaticojejunostomy ; ERBD, endoscopic retrograde biliary drainage ; PTGBD, percutaneous transhepatic gallbladder drainage

*The type of BDI was determined via the Bismuth–Strasberg classification system and the required treatment.

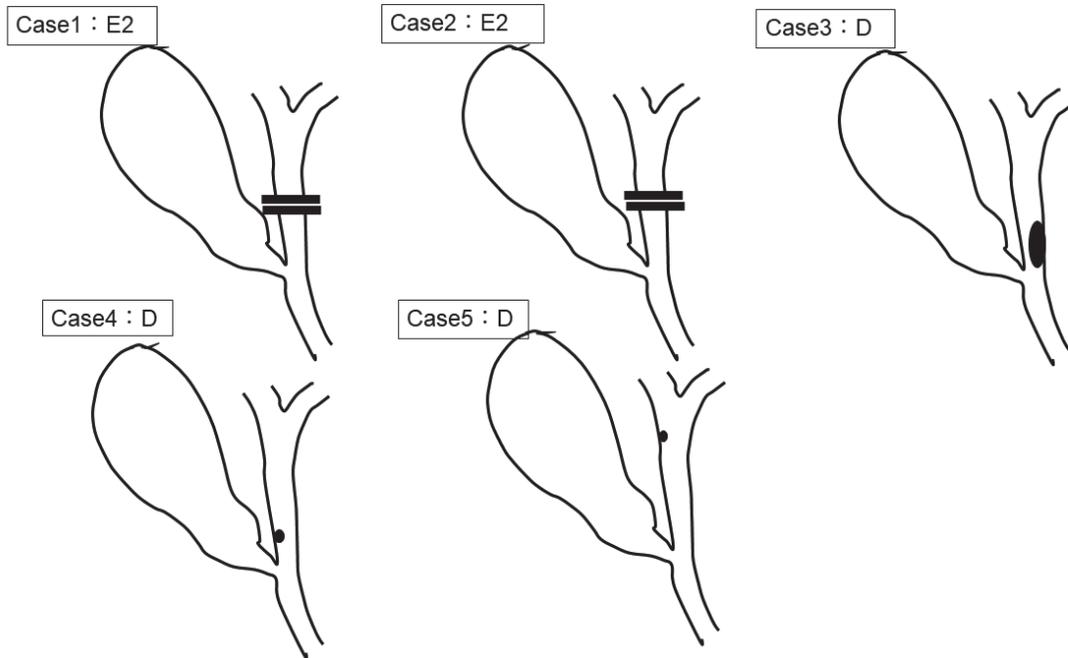


Fig. 1. Type of bile duct injury in each case
 Cases 1 and 2 : More than 50% transection of the common bile duct (Type E2). Case 3 : Partial (<50%) transection of common bile duct with reconstruction (Type D). Case 4 : Pin-hole common bile duct injury without reconstruction (Type D). Case 5 : Pin-hole common bile duct injury without reconstruction (Type D).

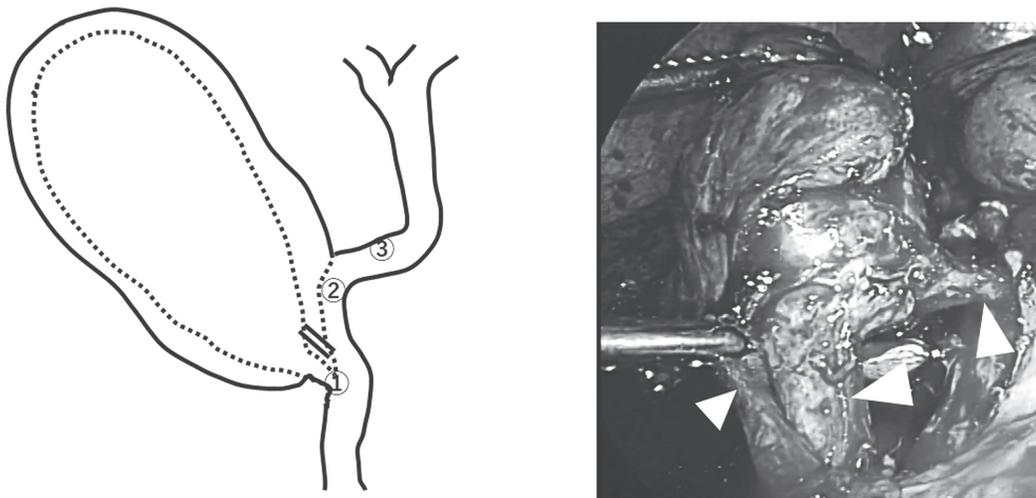


Fig. 2. Triple duct sign
 Triple duct sign appeared as the CBD was drawn to the gallbladder due to inflammation, making it difficult to create a critical view of safety and making it difficult to detach from the surroundings of the CBD. Left arrowhead : cystic duct (1) ; other arrowheads : CBD (2, 3).

sign represents the retraction of the common hepatic duct to the gallbladder, resulting in the visualization of 3 ducts (i.e., the cystic duct appearing as 1 duct, and the retracted common hepatic duct appearing as 2 ducts). The intention to perform IOC is reportedly associated with a reduced risk

of BDI in patients with a history of or a concurrent case of acute cholecystitis⁵. Therefore, to prevent BDI-LC we recommend that surgeons perform IOC to observe the anatomy of the biliary tree. For cases of BDI at our hospital, IOC was performed when BDI was suspected. If IOC is per-

formed before BDI may occur, the incidence rate of BDI will be decreased.

The incidence of BDI at our hospital has decreased since 2016 through the application of active IOC. By changing the strategy to laparoscopic subtotal cholecystectomy, the operation can be completed without BDI occurring. Strasberg et al. reported that the 3 conceptual goals of cholecystectomy are as follows : ① getting secure anatomical identification of key structures, ② making the appropriate decision not to perform total cholecystectomy when conditions are too dangerous for secure identification of key structures, and ③ completing the operation safely when secure anatomical identification of cystic structures is not possible³. The goal is safe completion of LC ; however, the triple duct sign can inform the choice of a transition to palliative surgery such as subtotal cholecystectomy, or a transition to open surgery. Since 2016, we have often performed subtotal gallbladder resection and have not found BDI. In the process of creating a CVS, being aware that the triple duct sign is a pseudo-CVS if helpful in cases with a high degree of inflammation. The surgeon should keep in mind that a triple duct sign often appears in patients with a high degree of inflammation owing to the risk of the CBD being damaged. We previously reported that complete transection of the CBD, which is rare in laparotomy, was the most common BDI pattern to occur during LC and that the underlying factor in the surgeon making this error was mistaking the CBD for the cystic duct⁶. Thus, avoiding the misidentification of anatomy may help prevent the occurrence of BDI, and the triple duct sign may help prevent such misidentification.

CONCLUSION

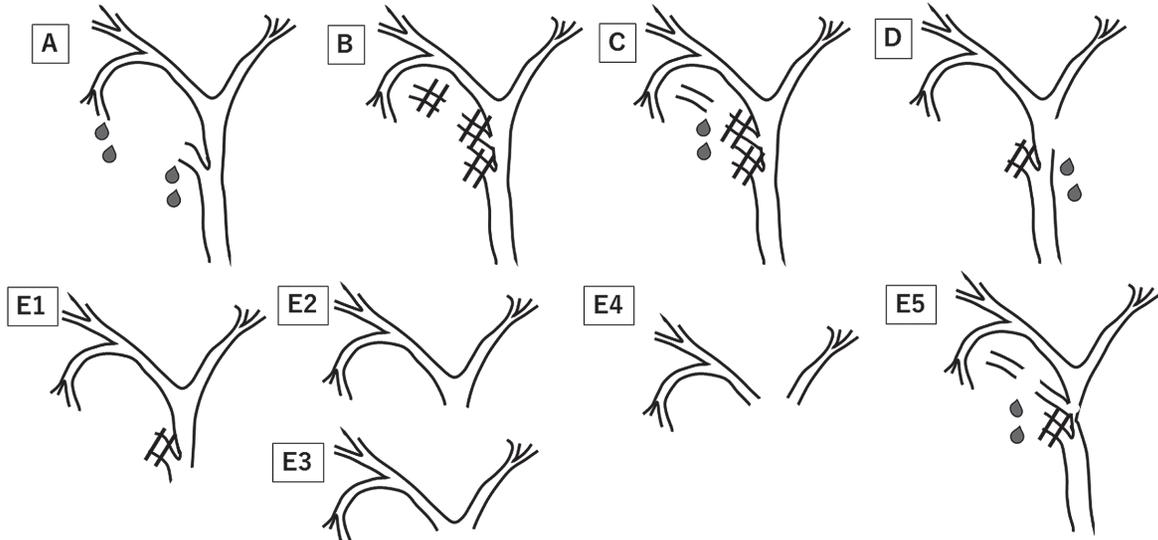
The triple duct sign is a potentially important finding in the prevention of major BDI during LC.

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Supplemental Figure. Bismuth-Strasberg classification
A : Cystic duct leaks or leaks from small ducts in liver bed. B : Occlusion of aberrant right hepatic duct. C : Transection of aberrant right hepatic duct. D : Partial (<50%) transection of major bile duct. E : Transection of >50%. E1 : Transection >2 cm from confluence. E2 : Transection <2 cm from confluence. E3 : Transection in hilum. E4 : Separation of major ducts in hilum. E5 : Type C and injury in hilum.