



Case report

Fluorescence cholangiography for detection of a cystic duct drained into an accessory hepatic duct: A case report

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ARTICLE INFO

Keywords:

Fluorescence
Indocyanine green
Laparoscopic cholecystectomy
Accessory hepatic duct

ABSTRACT

Introduction: Laparoscopic cholecystectomy is a safe and standard procedure, but serious bile duct injury may occur due to anatomical anomalies of the biliary tract, especially the accessory hepatic duct. The use of intraoperative fluorescence cholangiography with indocyanine green during laparoscopic cholecystectomy can reportedly prevent bile duct injury.

Presentation of case: A 55-year-old woman with upper abdominal pain was referred to our hospital. Laboratory investigations revealed elevated leukocytes and biliary enzymes, while computed tomography demonstrated increased fatty tissue density around the gallbladder. Magnetic resonance cholangiopancreatography and drip infusion cholangiographic-computed tomography showed that the cystic duct drained into an accessory hepatic duct. Due to the diagnosis of cholelithiasis with a biliary anomaly, we performed laparoscopic cholecystectomy using fluorescence cholangiography with indocyanine green. We were able to recognize the accessory hepatic duct and cystic duct, then safely dissect the cystic duct without bile duct injury.

Discussion: Laparoscopic cholecystectomy is generally regarded as a safe procedure, but complications and even mortalities can arise in patients with anatomical anomalies of the biliary tract. The aid of intraoperative fluorescence cholangiography with indocyanine green allowed to recognize and identify the accessory hepatic duct and cystic duct, allowing us to operate without injury to the bile duct.

Conclusions: Our experience supports the ease of use, safety, and effectivity of fluorescence cholangiography with indocyanine green. This may become the optimal standard technique to prevent bile duct injury.

1. Introduction

Laparoscopic cholecystectomy (LC) is one of the most common abdominal surgical procedures in recent years. However, the 1-year mortality rate for LC is 0.6 %, which is not low; it is unacceptable that patients still die due to LC every year [1]. In addition, the incidence of the bile duct injuries (BDI) during LC is still high, ranging from 0.3 % to 0.5 %. This can induce a series of serious complications, such as biliary fistula, bile peritonitis, and intra-abdominal abscess in the acute postoperative term, as well as bile duct stenosis, cholangitis, and intra-hepatic stones in the late postoperative term [2]. Sinha et al. demonstrated that patients with BDI during LC had about 6 times increased mortality compared to those without BDI (1-year mortality rate: 6.3 % vs 1 %, $p < 0.001$) [1].

One of the causes of BDI is the presence of an anatomic anomaly within the biliary tract, such as an accessory hepatic duct (AHD), which

leads to misidentification. This necessitates the use of an intraoperative examination that can identify the biliary tract in real time, and thus, fluorescence cholangiography with indocyanine green (FC-ICG) during LC has been studied and developed [3]. A randomized controlled trial demonstrated that the use of ICG had significantly better biliary tract identification rate for the common bile duct and cystic duct junction compared to identification without using ICG (69 % vs 45 %, $p < 0.001$, odds ratio = 2.5). Furthermore, two cases of BDI were observed only in the group which did not use ICG [4]. Thus, FC-ICG is an effective imaging modality which can provide a detailed intraoperative view of the biliary tract and prevent misidentification.

In this paper, we report a case wherein we were able to identify a biliary tract anomaly (cystic duct draining into an AHD) through the use of FC-ICG during LC, allowing us to safely operate without BDI.

The work was reported in line with the SCARE 2020 criteria [5].

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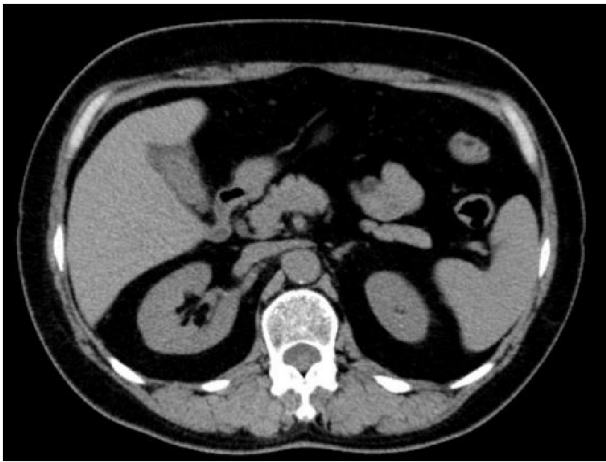


Fig. 1. Abdominal computed tomography (CT). Abdominal axial CT shows a slightly speckled hyper-absorbed area in the gallbladder, and increased fatty tissue density around gallbladder.

2. Case presentation

A 55-year-old female with upper abdominal pain which worsened after meals was referred to our hospital. She had a history of reflux esophagitis and was prescribed proton pump inhibitors by her previous doctor. However, her abdominal pain did not improve, prompting consult at our department for further work-up. Physical examination revealed persistent pain in the right hypochondrium, and laboratory investigations revealed the following: white blood cell of 12,600/ μ l, total bilirubin (T-bill) of 1.9 mg/dl, aspartate aminotransferase (AST) of 19 U/l, alanine amino transferase (ALT) of 25 U/l, γ -glutamyl transpeptidase (γ -GTP) of 76 U/l, and alkaline phosphatase of 342 U/l. Abdominal ultrasonography showed thickening of the gallbladder wall and multiple small stones in the gallbladder. On abdominal computed tomography (CT), there was a speckled area of hyperdensity suggestive of multiple small stones in the gallbladder, as well as increased fatty tissue density around the gallbladder (Fig. 1). No other abnormal findings were observed. The patient was diagnosed with acute cholelithiasis, and we conducted magnetic resonance cholangiopancreatography (MRCP), which revealed an anatomical anomaly within the biliary tract (Fig. 2a). Since we needed a more detailed understanding of the biliary tract, we used drip infusion cholangiographic-computed tomography (DIC-CT) (Fig. 2b). This revealed an AHD (early bifurcated main bile duct of posterior segment), the common hepatic duct (CHD), and the

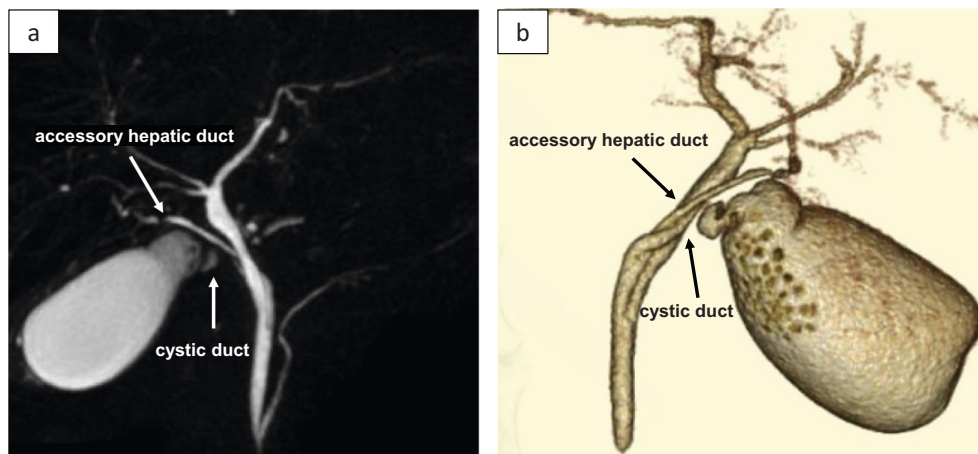


Fig. 2. Magnetic resonance cholangiopancreatography (MRCP) and drip infusion cholangiographic-computed tomography (DIC-CT). MRCP shows the accessory hepatic duct (the posterior segment of the bile duct) (a) and DIC-CT reveals the cystic duct drains into accessory hepatic duct (b).

cystic duct. Notably, the cystic duct drained into AHD; this is type 1 according to the Hisatsugu classification (Fig. 3).

One week after the diagnosis of cholelithiasis, we performed LC. We considered using FC-ICG because of the anatomical anomaly of the biliary tract. One hour before surgery, 1 ml ICG (Diagnogreen, Daiichi-Sankyo Pharma, Tokyo, Japan; 2.5 mg/ml) was intravenously injected. The operation was performed as follows. We started laparoscopic surgery with four ports at the umbilical area, subxiphoid area, subcostal arch along the right midclavicular line, and right abdomen. Because the inflammation around gallbladder was mild, we were able to identify the Rouviere sulcus and safely incise the gallbladder serosa. The neck of the gallbladder could be dissected almost smoothly, allowing us to expose the Calot triangle and achieve the critical view of safety (Fig. 4a). Although the AHD could almost be identified under ordinary white light, the use of FC-ICG immediately and clearly illuminated the AHD, CHD, and cystic duct as seen on the DIC-CT image. We could easily recognize the junction between the AHD and cystic duct, allowing us to safely and reliably dissect the cystic duct (Fig. 4b, c). Notably, the cystic artery was not illuminated because the ICG had been already washed out from the blood vessel; this prevented misidentification of the cystic duct and artery. The procedure was accomplished without bile duct injury (especially to the AHD), bile leakage, and bleeding. The operation time was 66 min, and the amount of bleeding was 5 ml. Grossly, the resected specimen was observed to have redness of the gallbladder mucosa, thickening of the wall, and numerous stones. The histological

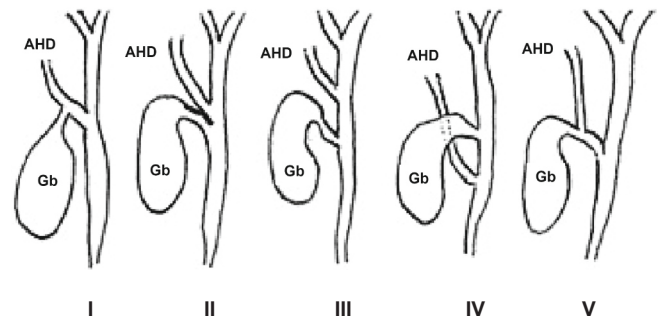


Fig. 3. Hisatsugu classification.

Type I, the cystic duct drains into the AHD. Type II, the cystic duct and the AHD drain into the common bile duct at the same level. Type III, the AHD drains into the common hepatic duct. Type IV, the AHD drains into the common bile duct at a site distal to the cystic duct confluence. Type V, the AHD drains into the cystic duct. AHD accessory hepatic duct, Gb gallbladder.

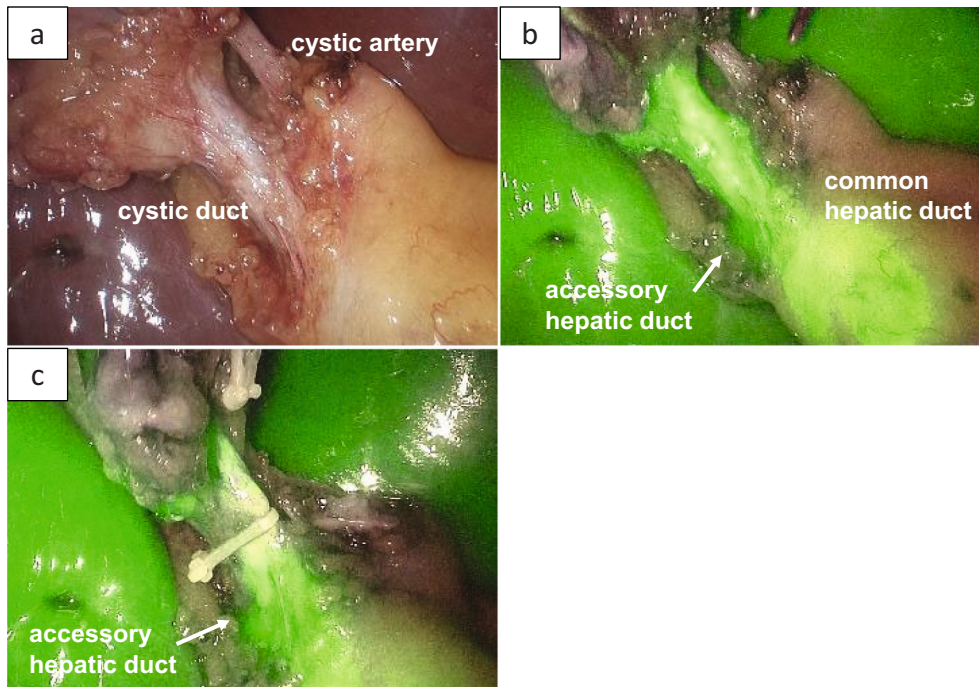


Fig. 4. Operative photographs.

Intraoperative photographs show the critical view of safety (a), and illuminated the accessory hepatic duct, cystic duct, and common hepatic duct by using the fluorescence cholangiography with indocyanine green (b). Also, the cystic artery and duct are safely dissected (c). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

examination was consistent with cholelithiasis with inflammation. No postoperative complications were observed, and the patient was discharged on the 5th postoperative day.

3. Discussion

Despite the efforts of surgeons to prevent the bile duct injuries (BDI) during laparoscopic cholecystectomy (LC), such as the development of safe surgical techniques and endoscopic instruments, training in dry and animal laboratories, and precise preoperative imaging to identify the biliary tract, the incidence of BDI has not decreased at all and can sometimes even cause mortality. Björn et al. demonstrated that patients who suffered from BDI had impaired survival compared to those without injury (1-year mortality: 3.9 % vs. 1.1 %), and the use of intraoperative cholangiography reduced the risk of death after cholecystectomy by 62 % (hazard ratio: 0.38) [6].

The causes of BDI could be divided into patient and surgeon factors. Patient factors include anatomical anomalies of the biliary tract and surgical difficulties due to inflammation/adhesion. On the other hand, surgeon factors include technical errors, such as carelessness, inexperience, and misidentification [7]. BDI is when the common bile duct, the common hepatic duct (CHD), or the accessory hepatic duct (AHD) is mistaken for the cystic duct and dissected. This is an unacceptable error and is often difficult to treat, requiring hepatoenteric anastomosis or long-term stenting [7]. Therefore, to prevent BDI, surgeons should properly identify the biliary tract and have pre/intraoperative knowledge of the existence of anatomical anomalies.

AHD is defined as the presence of drainage directly into the extra-hepatic bile duct, gallbladder, and cystic duct. This is occasionally encountered, with a reported prevalence of around 1.9 %–31.4 % [8]. In Japan, the Hisatsugu classification is used to describe the positional relationship between the AHD and the bile duct; this is clinically important because of the risk of BDI during LC [9]. Among its different types, type I, wherein the cystic duct drains into the AHD (the posterior segment of the bile duct), and type V, wherein the AHD drains into the cystic duct, are known to have a high possibility of BDI and thus require vigilant caution.

Intraoperative cholangiography using X-rays is used to determine the

exact orientation of the biliary tract. However, conventional cholangiography has disadvantages such as X-ray exposure, bile duct damage due to gallbladder puncture and cannulation, laborious examination requiring intraoperative delivery of X-ray equipment and administration of contrast medium, and prolonged operation time [3]. For these reasons, fluorescence cholangiography with indocyanine green (FC-ICG) was developed to satisfy the demand for an easy, safe, and simple intraoperative examination. FC-ICG, which uses near-infrared light to visualize the fluorescence in bile, is a modality that can confirm the anatomy of the biliary tract in real time at any point in time during LC, while keeping the aforementioned disadvantages to a minimum. Ishizawa et al. revealed that the identification of common bile duct and cystic duct using FC-ICG was possible in all 52 cases (100 %) of their study [3].

4. Conclusions

FC-ICG has been applied not only in LC, but also in hepatobiliary surgery, specifically in visualizing structures during hepatocellular carcinoma resection, determining the extent of hepatic resection during liver transplantation, and exploring lymph node metastasis in biliary tract cancer [3,10]. If this examination could reduce surgical complications and improve patient prognosis, it will play an even greater important role in various surgical fields in the future. Our investigation proves that this is useful for LC, but even in cases with a normal biliary tract, this examination may be safe enough to reduce the incidence of BDI and could become a standard technique.

Abbreviations

LC	laparoscopic cholecystectomy
AHD	accessory hepatic duct
CBD	common bile duct
CHD	common hepatic duct
ICG	indocyanine green
FC	fluorescence cholangiography
WBC	white blood cell
T-bill	total bilirubin

AST	aspartate aminotransferase
ALT	alanine amino transferase
γ -GTP	γ -glutamyl transpeptidase
ALP	alkaline phosphatase
CT	computed tomography
MRCP	magnetic resonance cholangiopancreatography
DIC-CT	drip infusion cholangiographic-computed tomography

Ethics approval and consent to participate

Not applicable.

Consent for publication

Written informed consent was obtained from the patient involved in this publication and accompanying images. A copy of this written consent is available for review by the Editor-in-Chief of this journal.

Availability of data and materials

The data supporting the findings of this study are available within the article.

Funding

No Funding.

Guarantor

Mitsuru Kinoshita.

Registration of research studies

None.

Author contribution

MK wrote the paper. GM, KM, HO provided the cases and reviewed and edited the manuscript. All authors read and approved the final manuscript.

Declaration of competing interest

The authors declare that they have no competing interests.

Acknowledgements

This manuscript was proofread by a professional editor who is a native speaker of English at enago Edit (<https://www.enago.jp/>).

Provenance and peer review

Not commissioned, externally peer-reviewed.

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