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Case Report

Define before you divide: surgical lessons from cystic duct insertion into the right hepatic duct

Sze Mun Thor*, Xin Yi Goai, Georgi D. Atanasov

Department of General Surgery, Goulburn Valley Health, Shepparton, Victoria, Australia

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***Correspondence:**
Dr. Sze Mun Thor,
E-mail: szemun1210@gmail.com

ABSTRACT

Anatomical variations of the cystic duct are uncommon but clinically significant, as unrecognized variants increase the risk of catastrophic bile duct injury during cholecystectomy. We report a case of a 47-year-old woman presenting with biliary colic and transient cholestatic liver enzyme derangement, in whom an aberrant cystic duct draining directly into the right hepatic duct (RHD) was identified intraoperatively during cholangiography. The case highlights operative decision-making and reviews the role of dedicated preoperative imaging in detecting biliary duct anomalies to optimize surgical planning.

Keywords: Cystic duct anomaly, Aberrant biliary anatomy, Cholecystectomy, Bile duct injury

INTRODUCTION

Laparoscopic cholecystectomy is one of the most commonly performed general surgical procedures worldwide. In standard anatomy, the cystic duct joins the common hepatic duct to form the common bile duct (CBD); however, deviations in cystic duct course and insertion are frequently encountered. Reported rates of cystic duct variation range from 23% to 49% on magnetic resonance cholangiopancreatography (MRCP).[1,2]

Unusual insertions, including drainage into the RHD, can lead to misidentification during dissection and may result in major injury, including complete transection of the RHD or CBD, if unrecognised.[1,3]

Preoperative imaging and use of intraoperative cholangiography (IOC) are therefore valuable for defining biliary anatomy and supporting safer operative strategy. We present a rare cystic duct variant and discuss the role of advanced imaging modalities in preoperative planning, as well as intraoperative strategies in preventing bile duct injury.

CASE REPORT

A 47-year-old female presented to the emergency department with upper abdominal pain consistent with biliary colic. The pain was intermittent, precipitated by fatty meals, and had been occurring episodically for several years, typically resolving within two hours. On this occasion, the pain persisted for approximately 12 hours without resolution, prompting presentation.

She denied associated nausea, vomiting, fever, chills, or rigors. She had no known medical comorbidities, did not smoke, and did not consume alcohol.

On examination, her vital signs were within normal limits and she was afebrile. Abdominal examination was soft and non-tender following administration of analgesia, with no peritonism.

Initial laboratory investigations demonstrated a normal white cell count. Liver function tests were deranged, with a bilirubin of 44.2 µmol/l, alanine aminotransferase (ALT) 829 U/l, aspartate aminotransferase (AST) 811

U/L, gamma-glutamyl transferase (GGT) 916 U/l, and alkaline phosphatase (ALP) 195 U/l. C-reactive protein (CRP) was mildly elevated at 14.1 mg/l.

A CT abdomen and pelvis showed no evidence of acute cholecystitis and no radiopaque gallstones. Subsequent ultrasound of the abdomen demonstrated an equivocal appearance of the gallbladder, concerning for porcelain gallbladder versus a densely packed calculus, with a CBD diameter of 5 mm.

Her bilirubin normalized over the subsequent two days, and a decision was made to proceed with laparoscopic cholecystectomy with IOC on day three of admission.

During IOC, the cystic duct was found to drain directly into the RHD rather than the common hepatic duct (Figure 1). In response to this unexpected anatomy, a fundus-first dissection was performed, with careful mobilization of the gallbladder prior to division of the cystic duct to minimize the risk of injury to the biliary tree. No accessory ducts were identified. A surgical drain was left in situ to monitor for postoperative bile leak.

The IOC demonstrated a filling defect in the mid CBD (Figure 1), prompting postoperative MRCP. MRCP again demonstrated the aberrant drainage of cystic duct directly into RHD, with no evidence of choledocholithiasis. The patient's bilirubin and liver enzymes remained within normal limits postoperatively, and drain output was minimal. The drain was removed on postoperative day three, and the patient was discharged home.

At two-week outpatient follow-up, she reported complete resolution of symptoms. Histopathology demonstrated chronic cholecystitis with cholelithiasis. She was discharged from surgical follow-up and has not re-presented with biliary symptoms.

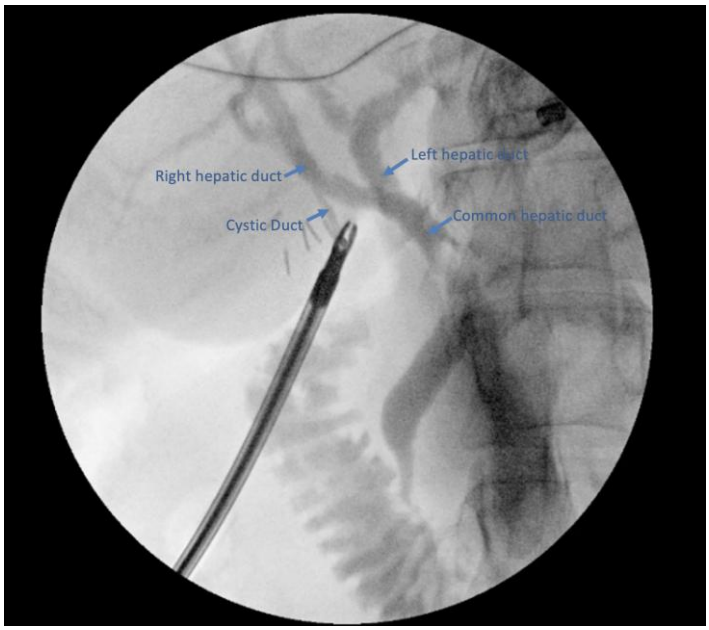

Figure 1: Intraoperative cholangiogram demonstrating cystic duct insertion to RHD.

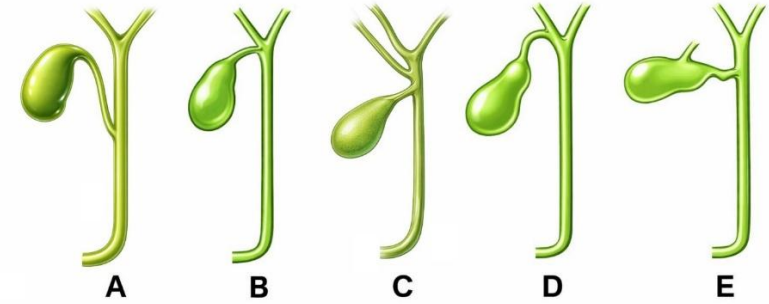

Figure 2 (A-E): Benson and page classification.[4] (A) The cystic duct inserts low, either laterally with a shared sheath around both the cystic duct and the CBD, or medially at/near the ampulla of Vater; (B) the cystic duct joins the common hepatic duct high at the porta hepatis alongside the right and left hepatic ducts, creating a "trifurcation" patternl; (C) a variation involving an accessory hepatic duct; (D) the cystic duct drains abnormally into the RHD; (E) a cholecystohepatic duct is present (also called the duct of Luschka).

DISCUSSION

Anatomical variation of the cystic duct is common; however, direct drainage of the cystic duct into the RHD represents an exceptionally rare configuration with significant surgical implications. In established classifications of cystic duct anatomy, the Benson and Page classification is one of the most widely cited systems describing cystic duct insertion patterns (Figure 2).[4] This classification categorises cystic duct anatomy into five types (A-E) based on the site and manner of insertion into the biliary tree. Type D, defined as direct insertion of the cystic duct into the RHD, represents one of the rarest configurations within this system and is considered an ectopic or aberrant insertion rather than a normal anatomical variant.[5] Published surgical and radiological series consistently report the incidence of this anomaly to be well under 1%, most commonly in the range of 0.3-0.7%, underscoring its rarity.[3,5] Consequently, most surgeons will encounter this configuration rarely, if ever, during routine practice, which increases the risk of misidentification and iatrogenic bile duct injury.

Pre-operative identification of such anomalies remains challenging. Ultrasound, while appropriate as a first-line investigation for biliary colic and cholelithiasis, has limited capability in defining cystic duct anatomy or its confluence with the biliary tree, especially when they are not dilated.[2] MRCP is the most useful non-invasive modality for delineating biliary anatomy and can occasionally identify aberrant cystic duct insertions, particularly when there is clinical suspicion raised by atypical liver function test derangement, prior biliary events, or equivocal ductal anatomy. Nevertheless, even MRCP has imperfect sensitivity for cystic duct anomalies, as the cystic duct is small, variably oriented, and prone to obscuration by inflammation or artefact.[6] As a result, many cases such as the present one are only recognised intraoperatively. This highlights that while pre-operative imaging may aid surgical planning in selected patients, absence of a detected anomaly on imaging does not exclude its presence.

Once an anomalous cystic duct insertion into the RHD is identified or suspected intraoperatively, the surgical approach becomes the critical determinant of patient safety. This variant poses a particularly high risk because the RHD may be mistaken for the cystic duct and inadvertently clipped or divided, resulting in major bile duct injury.[3] Although attainment of the critical view of safety (CVS) is fundamental during laparoscopic cholecystectomy, CVS alone may be insufficient in the presence of aberrant biliary anatomy, as the visual criteria can be misleading when ductal confluence is abnormal.[7] In this context, surgeons must adopt a "define the anatomy before division" mindset.

Strategies to mitigate injury include use of routine IOC to clarify ductal relationships, minimising deep dissection in Calot's triangle once abnormal anatomy is suspected, and a low threshold for bail-out procedures.[8-10] These include subtotal cholecystectomy, a fundus-first or cystic plate approach, or conversion to open surgery if safe progress cannot be ensured laparoscopically.[10] Importantly, no tubular structure should be clipped or divided until its identity is unequivocally established. Such a cautious, anatomy-driven approach is particularly important when the RHD lies in close proximity to, or is directly involved in, cystic duct drainage.

In summary, cystic duct drainage into the RHD is an extremely rare and surgically hazardous anatomical anomaly. Pre-operative imaging may assist in selected cases but cannot be relied entirely upon to exclude variant anatomy. Clinical vigilance, intraoperative recognition, meticulous dissection, and early adoption of damage-avoidance strategies are essential to prevent catastrophic bile duct injury. This case reinforces the importance of maintaining a high index of suspicion for biliary anomalies and prioritising surgical safety over procedural completion when unexpected anatomy is encountered.

CONCLUSION

Cystic duct insertion into the RHD represents an extremely rare anatomical variant, corresponding to type D in the Benson and Page classification, and carries a substantial risk of major bile duct injury if unrecognised. This case highlights that pre-operative imaging may fail to identify hazardous biliary anatomy and that such variants are often only detected intraoperatively. Meticulous dissection, early recognition of abnormal anatomy, and strict adherence to safe cholecystectomy principles, supported by timely use of IOC and damage-avoidance strategies, are critical to preventing RHD injury. Awareness of this rare variant and a low threshold to modify the operative approach are essential to ensure patient safety when unexpected biliary anatomy is encountered.

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