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Indocyanine Green Fluorescence-Guided Laparoscopic Cholecystectomy with Right Trabecular Accessory Gallbladder Removal

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Background	A 57-year-old female presented with biliary colic with a possible duplicated gallbladder.
Summary	The patient is a 57-year-old female who presented with a possible duplicated gallbladder. She developed two episodes of severe biliary colic. Abdominal ultrasound showed choledocholithiasis within the right intrahepatic biliary duct with associated duct dilatation, which was confirmed with endoscopic retrograde cholangiopancreatography. She later underwent magnetic resonance cholangiopancreatography, which demonstrated an oblong, saccular gallbladder with a stone-containing accessory gallbladder emanating from the right hepatic duct. The patient underwent laparoscopic cholecystectomy with intraoperative cholangiogram with the removal of the duplicated gallbladder. Due to the atypical anatomy of the gallbladder and biliary system, intraoperative indocyanine green fluorescence (ICG) was used in identifying and confirming the complex anatomical variant in this particular case. The patient underwent the operation with no intraoperative complications. The postoperative course was uneventful, and the final pathology confirmed a right trabecular type of accessory gallbladder.
Conclusion	Preoperative diagnosis of these anomalies can be difficult and technically challenging intraoperatively. Intraoperative cholangiography is required in these cases. However, with intraoperative ICG, visualization of this complex anatomical variant was enhanced, notably by being able to continually view the anatomy under both normal and fluorescent conditions while operating.
Key Words	accessory gallbladder; duplicated gallbladder; laparoscopic cholecystectomy; ICG fluorescence

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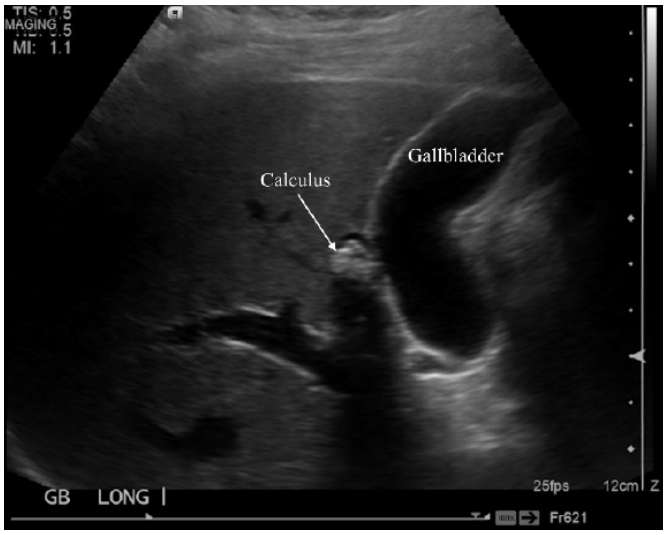
Case Description

Duplicated gallbladder or accessory gallbladder is a rare anatomical variance. Most patients present with gallstone-related symptoms or complications, including biliary colic and acute cholecystitis, while others present with acute pancreatitis and biliary malignancy. In this case, removing both actual and duplicated gallbladders is recommended; however, establishing the preoperative diagnosis and intraoperatively identifying relevant anatomical structures can be challenging.

We report a case of a rare trabecular type of duplicated gallbladder. The patient is a 57-year-old female with no significant past medical history who presented with a possible duplicated gallbladder. The patient was in her usual state of health until two months prior, when she developed two episodes of severe biliary colic lasting 30 to 40 minutes in each episode. She was afebrile and not jaundiced.

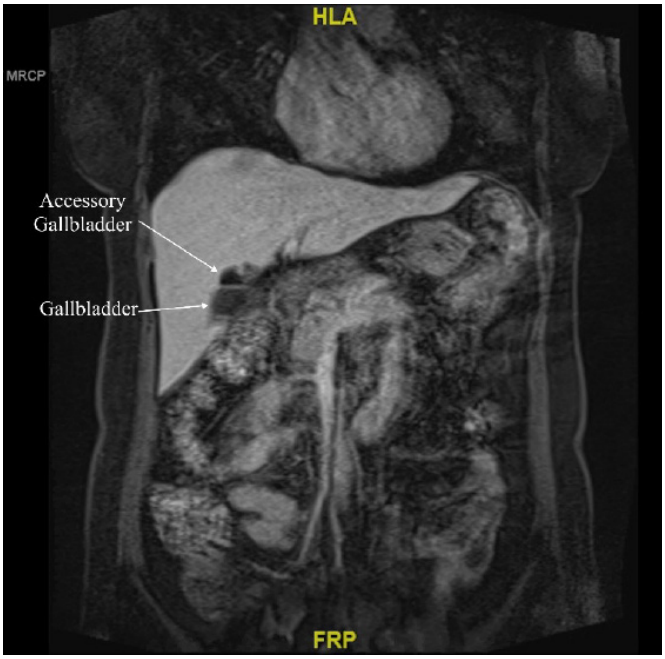
Figure 1. Abdominal Ultrasound Demonstrated Choledocholithiasis Within Presumed Right Intrahepatic Biliary Duct with Associated Duct Dilatation. Published with Permission



Her white blood cell count and liver function tests were within normal limits. Further workup showed gastritis on upper endoscopy. Her initial abdominal ultrasound from an outside facility did not detect any gallbladder anomalies but described choledocholithiasis within the right intrahepatic biliary duct with associated duct dilatation (Figure 1). These findings were subsequently confirmed with endoscopic retrograde cholangiopancreatography (ERCP); however, the stones were not retrieved out of concern for perforation and presumed need for surgical management.

Following ERCP, the patient underwent magnetic resonance cholangiopancreatography (MRCP), which demonstrated an oblong, saccular gallbladder with a stone-containing accessory gallbladder or single dilated intrahepatic duct along the inferior inferomedial aspect of the right hepatic lobe, which was seen to communicate with the right hepatic duct (Figure 2).

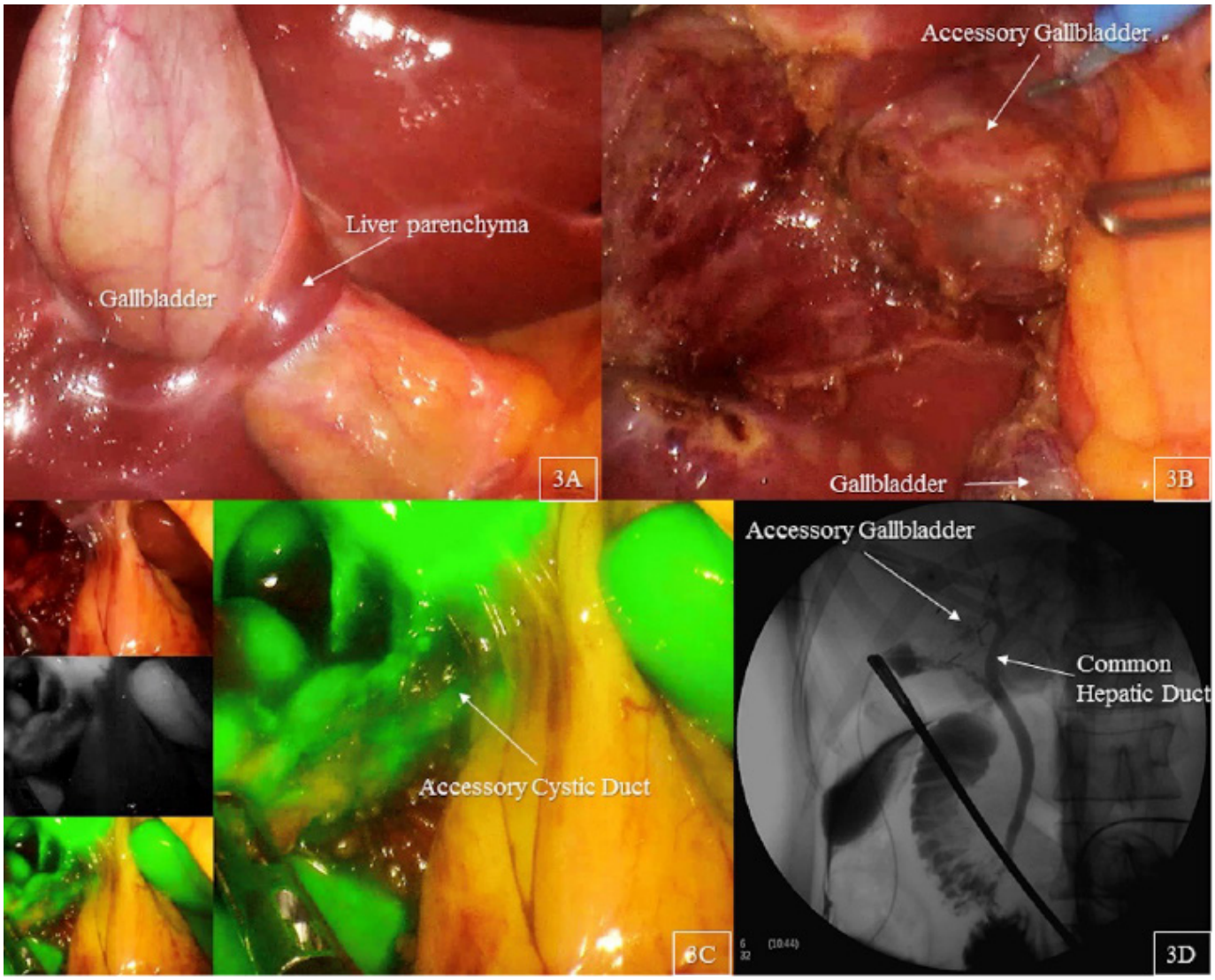
Figure 2. Magnetic Resonance Cholangiopancreatography Demonstrated an Oblong, Saccular Gallbladder with Stone-Containing Accessory Gallbladder. Published with Permission



Given the patient's presentation and the risks of future complications, if left untreated, including common bile duct obstruction, acute cholangitis, cholecystitis, and pancreatitis, as well as rare complications, including gallbladder perforation, fistula, and malignancy, the patient was offered laparoscopic cholecystectomy with intraoperative cholangiography with the removal of possible stone-containing duplicated gallbladder or accessory gallbladder. Due to the atypical anatomy of the gallbladder and biliary system, intraoperative indocyanine green fluorescence (ICG) was utilized in this particular case. The ICG was administered intravenously 45 minutes before surgery.

The patient underwent the operation with no intraoperative complications (Figure 3). Final pathology showed no histopathologic abnormality in both actual and accessory gallbladders. The accessory gallbladder was full of black-tan multifaceted calculi ranging from 0.1 to 0.3 cm in dimension; no stones were found in the native gallbladder. The postoperative course was uneventful, and the patient was doing well at a two-week follow-up.

Figure 3. Intraoperative Findings. Published with Permission



A) Showing superior portion of gallbladder body was circumferentially wrapped by thin tongue of liver parenchyma; B) accessory gallbladder was embedded in hepatic lobe; C) indocyanine green fluorescence was used to confirm anatomical variant of biliary structures; D); and intraoperative cholangiography demonstrated contrast filling stone-containing accessory gallbladder through accessory duct which came off from right hepatic duct

Discussion

The gallbladder and extrahepatic biliary ducts are derived from pars cystica or caudal bud after the fourth week of gestation. The cranial bud or pars hepatica later develops into the liver and intrahepatic biliary ducts. During the development and migration of these buds between the fifth and twelfth weeks of gestation, any abnormalities can result in an anatomical variance of a duplicated or accessory gallbladder.[1–4]

Boyden first reported these cases in 1929 and initially classified these anomalies into the bi-lobed gallbladder and true gallbladder duplication.[5] Harlaftis later modified the classification by describing three main types of gallbladder duplication based on embryogenesis.[6] However, another type, an undrained accessory gallbladder (without any connected cystic duct), was later identified in two cases.[7] In a systemic review by Darnis et al., a total of 181 patients were diagnosed with multiple or duplicated gallbladders from 1990 to 2017. Of these, 50% were classified as type

II Harlatis classification; 43% were type I; 5% were type III.[7] In this case, the patient was found to have a trabecular type, which is a subtype of type II. The incidence of the right trabecular type reported was 9% of all types, while the left trabecular type was reported in 3%.[7]

The majority of these patients were diagnosed with accessory gallbladder during their workup or treatment of gallstone-related symptoms.[7–10] Abdominal ultrasound and computed tomography (CT) had been used to initially detect these anomalies with similar sensitivity of 65 to 66%. At the same time, ERCP and MRCP were found to have a higher sensitivity of 89% and 97%, respectively.[7,11,12] However, one-fourth of these patients were diagnosed intraoperatively.[7]

The accessory gallbladder can be challenging not only in initial diagnosis but also intraoperatively with a potential risk of biliary injury. The incidence of bile duct injury during cholecystectomy is reported ranging from 0.1 to 1.5% in the general population.[13,14] However, in those with more complex anatomy, such as duplicated gallbladder, the risk of biliary injury could be higher due to difficulty identifying the anatomical variants, technical challenges in dissecting the relevant structures, and inflammation surrounding the gallbladder and biliary structures in those with cholecystitis. Intraoperative cholangiography during cholecystectomy has been shown to reduce the incidence and degree of biliary injury. Moreover, it is recommended, especially in complicated cholecystectomy, to confirm the anatomy to reduce the risk of biliary injury.[14,15]

With advances in intraoperative visual technology, ICG-enhanced fluorescence has been utilized in many types of both open and laparoscopic procedures, including hepatobiliary, colorectal, head and neck, and renal surgery.[16–18] ICG has also been used in standard laparoscopic cholecystectomies to identify the extrahepatic biliary structure.[19] In a systematic review of 12 prospective cohorts and one non-randomized controlled trial, it was demonstrated that good visualization was obtained using ICG fluorescence during cholecystectomy. Moreover, both intraoperative cholangiography and ICG provided visualization of the biliary system before dissection.[20] In this unique case, the ICG fluorescence facilitated identifying and confirming the variant anatomy before dissection and during dissection of the gallbladder and biliary structures, which resulted in an avoidance of biliary injury due to false identification of the critical structures: the accessory gallbladder that was embedded in the liver lobe as well as the accessory cystic duct and arteries that came out directly from the liver bed.

Conclusion

We present a rare case of right trabecular accessory gallbladder undergoing laparoscopic removal of both gallbladders. Preoperative diagnosis of these anomalies can be difficult and can be technically challenging intraoperatively. Intraoperative cholangiography is required in these cases. However, with the use of ICG-enhanced fluorescence, visualization of this complex anatomical variant was enhanced.

Lessons Learned

Correct identification of the biliary structures and both gallbladders is crucial before dissecting the gallbladders. A combination of intraoperative cholangiography and ICG fluorescence enhanced visualization of the biliary system in this technically challenging and highly atypical case.

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