Bile leak after elective laparoscopic cholecystectomy: Role of MR imaging

Bile leak after elective laparoscopic cholecystectomy: Role of MR imaging

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ABSTRACT

Increasing hepatobiliary laparoscopic surgeries have lead to a rise in injury to the biliary tree and other complications like bile leak. Ultrasonography (US) and computed tomography (CT) cannot reliably distinguish bile from other postoperative fluid collections. Magnetic resonance (MR) imaging with hepatobiliary agents and MR cholangiopancreatography provide anatomic and functional information that allows for prompt diagnosis and excludes any other concomitant complications. We report a case of post-cholecystectomy bile leak in a 42-year-old female who presented with persistent dull abdominal pain after the intervention; we emphasize the role of MR imaging in achieving the correct diagnosis.

CASE REPORT

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A 42-year-old female was re-admitted to the hospital 8 days after elective laparoscopic cholecystectomy for gallstones because of dull right upper quadrant (RUQ) pain that increased with meals. Physical examination disclosed no abnormalities except for mild RUQ tenderness and fever (98.6 °F, 37 °C). Blood analyses revealed mild elevation of total bilirubin (2.1 mg/dL) and serum inflammation markers (ESR, CRP and fibrinogen); other laboratory studies including liver and pancreas function tests were within normal limits. Upper abdomen US scan (Fig. 1) revealed moderate nonspecific perihepatic and peripancreatic fluid containing some echogenic spots, without any significant biliary dilatation. Contrast enhanced CT was performed (Fig. 2) and confirmed the presence of moderate water-density free fluid in abdomen, reported as compatible with post-operative fluid collection; no free peritoneal air, biliary duct dilatation or radiopaque residual biliary calculi were seen. The patient was dismissed with conservative treatment including non-steroidal anti-inflammatory drugs and broad-spectrum antibiotic; however, due to persistence of symptoms, further contrast enhanced CT was requested by the referring surgeon. The radiologist chose to alternatively perform MR-cholangiopancreatography (MRCP) and MR imaging before (Fig. 3, Fig. 4, Fig. 5) and after intravenous administration of 0.025 mmol per kilogram of body weight of gadoxetic acid disodium (Gd-EOB-DTPA, Primovist; Bayer-Schering, Berlin, Germany) (Fig. 6). MR exam revealed a 2.6 x 5.7 x 2.6 cm ovoid thin-walled fluid collection with medium signal intensity on T1W images and high on T2W images located in the gallbladder fossa; MRCP depicted a small connection between the fluid collection and the cystic duct remnant and this was confirmed by evidence of contrast media accumulation in the connection during hepatobiliary phase scan (20 minutes after contrast medium injection); common bile duct diameter was at the upper limits (0.9 cm); no residual biliary calculi were seen (Figs. 3-6). The correct diagnosis of postoperative bile leak was so achieved.

The patient declined any further endoscopic or percutaneous treatment and was followed up clinically. Upper abdomen US scan was then performed after 2 months and

showed complete resorption of the previously noted fluid collection.

DISCUSSION

Increasing hepatobiliary surgeries have lead to a rise in injury to the biliary tree and other complications like bile leak. Bile duct injury rates after elective laparoscopic cholecystectomy have been reported to range from 0.2% to 7% compared to 0.2-0.4% after open cholecystectomy [1-4]. Postoperative bile duct injuries include the presence of leak, stricture, or complete transection and excision of a segment of duct, with or without obstruction of the proximal biliary tree by surgical clips and have been classified by using the Bismuth or Strasberg classification. The Bismuth classification (Table 3) is based on the localization of biliary strictures according to the distance from the biliary confluence [5] but does not include the entire spectrum of bile duct injury. Consequently, Strasberg et al [3] made the Bismuth classification much more comprehensive by including other types of laparoscopic extrahepatic bile duct injury (Table 4). Significant postoperative bile leak may occur in up to 1% of patients undergoing laparoscopic cholecystectomy compared to 0.5% after open cholecystectomy [1-4] and is mainly caused by a slipped cystic duct ligature or leak from an accessory or anomalous bile duct. Bile leak usually presents within the first week but can manifest and be diagnosed up to 30 days after surgery; symptoms are unspecific and could be related to other postoperative complications [4,6]. Clinical manifestations of bile leak include persistent abdominal tenderness, generalized malaise and anorexia. Bile leak after surgery resulting in intraperitoneal bile collection is typically not contaminated by bacteria and usually does not result in severe bile peritonitis [7]. Detecting and locating bile leak may not be so easy; patients usually undergo US and CT examinations but these methods cannot reliably distinguish bile leak from other postoperative fluid collection such as blood, pus, or serous fluid because of similar densities. US is readily available, noninvasive and provides good anatomic and contrast resolution. CT provides higher spatial resolution and better demonstrates fluid collection morphology and site; it is also essential to define collections that require percutaneous or surgical drain. However nor US neither CT can establish the precise location or the active state of bile leak, because bile collection may not be close to the leak site and occasionally it may be even intrahepatic.

Hepatobiliary scintigraphy may give functional information demonstrating the presence of an active leak, but spatial resolution is poor and identification of the leak site can be challenging: in 81% of patients hepatobiliary scintigraphy does not enable documentation of leak location, thereby limiting its feasibility in deciding whether to use endoscopic, percutaneous, or surgical treatment approach [8]. Other weaknesses of hepatobiliary scintigraphy are that extrabiliary structures are not visualized, so no information about them can be provided; it has poor sensitivity in patients with hepatic dysfunction and, furthermore, large bile duct defect with preferential bile flow in a path of least resistance may not show activity in the duodenum and thus may be misinterpreted as complete bile duct obstruction.

Endoscopic retrograde cholangiopancreatography (ERCP) and percutaneous transhepatic cholangiography (PTC) can identify a continuing bile leak, provide exact anatomical diagnosis and, at the same time, allow for treatment of injury by appropriately decompressing or dilating the biliary tree. However these methods are invasive, use considerable amount of X-rays and are associated with the risk of complications like severe acute pancreatitis (mainly after ERCP), bleeding and cholangitis (after PTC). Other disadvantages include lack of detection of extrabiliary abnormalities and nonvisualization of ducts upstream or downstream from an obstructing lesion (stricture, stone). Moreover PTC could sometimes be technically difficult because intrahepatic bile ducts are usually not dilated.

MR cholangiopancreatography (MRCP) is a noninvasive cholangiographic technique that uses heavily T2W images to demonstrate biliary anatomy, exploiting the relatively high signal intensity of static fluids in the biliary tract while background structures show decreased signal. Current standard MRCP protocols generally consist of both 2D and 3D heavily T2W sequences, usually fast spin-echo or turbo spin-echo (FSE or TSE) or variants (including single-shot fast spin-echo and fast-recovery fast spin-echo)[9]. In adjunct to these sequences fat-saturated T1W imaging with contrast agents that are specifically excreted into the bile can be used to provide functional assessment of the biliary system and to demonstrate the active state of biliary leak by visualizing the contrast material pooling outside the biliary tree. These contrast agents include gadobenate dimeglumine (Gd-BOPTA) (Multihance, Bracco Diagnostics, Milan, Italy), gadoxetic acid disodium (gadoxetate disodium, or Gd-EOB-DTPA) (Primovist or Eovist; Bayer Healthcare, Leverkusen, Germany), and mangafodipir trisodium (Mn-DPDP) (Teslascan; Nycomed, Zurich, Switzerland); intravenous injection results in biliary contrast material excretion that is suitable for T1W imaging approximately 15-90 minutes after injection. These agents shorten the T1 relaxation time of bile, resulting in high-signal intensity bile at T1W imaging [10,11]. This technique allows for the differentiation of extrahepatic biloma from perihepatic fluid collection of nonbiliary origin, by demonstrating contrast material leakage into the former. It is useful to remember that conventional T2W MRCP should be performed before excretion of hepatobiliary contrast material into the biliary tree because this can determine shortening of T2 relaxation time of bile and interfere with optimal visualization of biliary fluid in this sequence. Furthermore, it should be reminded that liver function has huge effect on image quality and adequate contrast material filling in bile duct requires normal or not substantially reduced liver function [12].

Patients with bile leak but without significant major duct injury usually do not require intervention, but percutaneous external drainage of the biloma, ERCP with sphincterotomy, or placement of temporary stent may be necessary. Major bile duct injury with or without significant bile leak requires more invasive therapy, such as surgical biliary reconstruction [13,14].

TEACHING POINT

MR cholangiopancreatography combined with hepatobiliary contrast-enhanced MR imaging is a useful approach that provides comprehensive information about the biliary system and can detect biliary leak and differentiate it from other post-operative complications.

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FIGURES

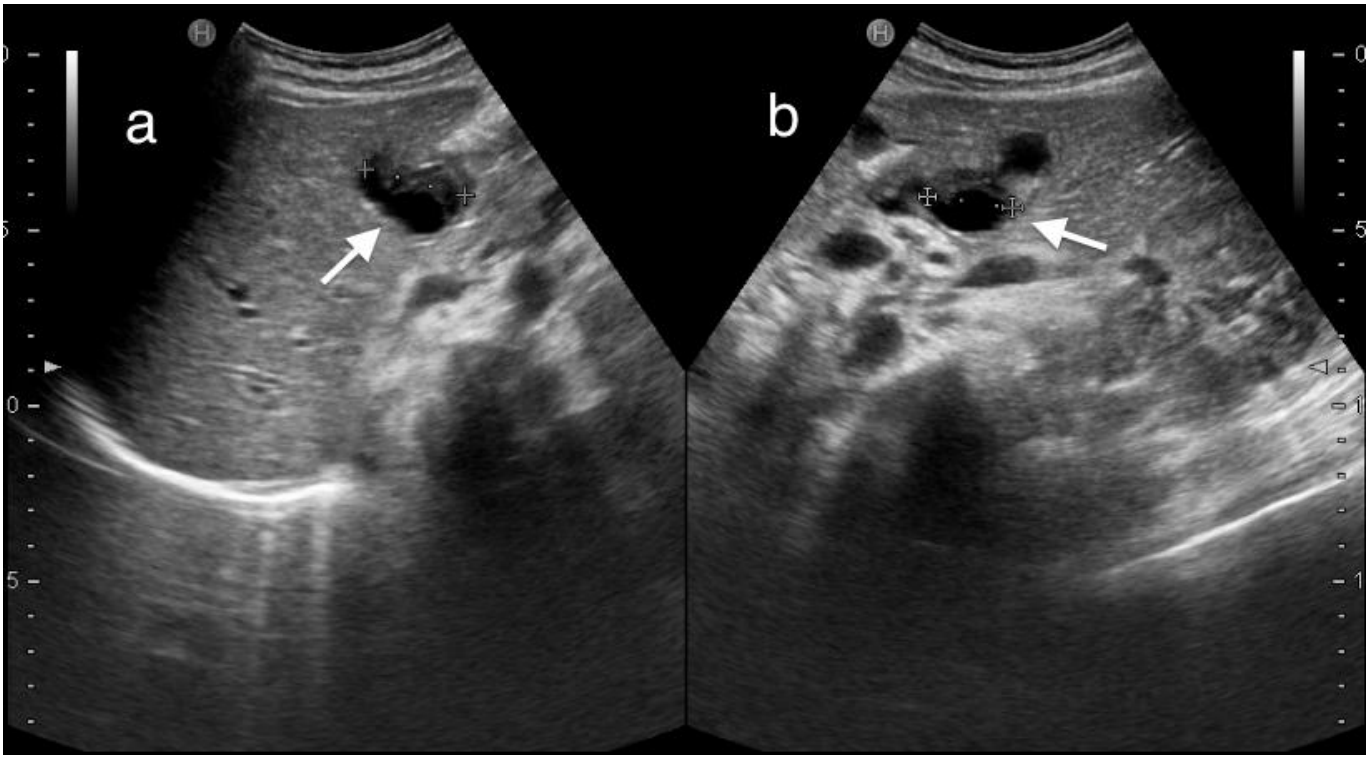

Figure 1. 42-year-old female with bile leak after laparoscopic cholecystectomy. Upper abdomen US performed 8 days post intervention. Longitudinal (a) and transverse (b) scans obtained at hepatic hilum show moderate nonspecific perihepatic and peripancreatic fluid (white arrow) containing some echogenic spots, without any significant biliary dilatation. (Hitachi scanner, convex probe, 3.5 MHz)

Figure 2. 42-year-old female with bile leak after laparoscopic cholecystectomy. Contrast-enhanced CT scan of the abdomen performed 8 days post intervention. (a) Scan obtained at the confluence of hepatic ducts shows surgical clips in status post cholecystectomy (black arrow) and a focal liver lesion in the sixth segment (white arrow) consistent with hemangioma. (b, c) Scans obtained at inferior levels show moderate amount of water-density free peritoneal fluid (black arrowhead); the common bile duct is not dilated (white arrowhead); no free peritoneal air or radiopaque residual biliary calculi are seen. (CT Siemens Somatom; Protocol: 183 mAs, 100 kV, 3 mm slice thickness, 1.5 ml/kg of Ultravist 370, Bayer-Schering, venous phase)

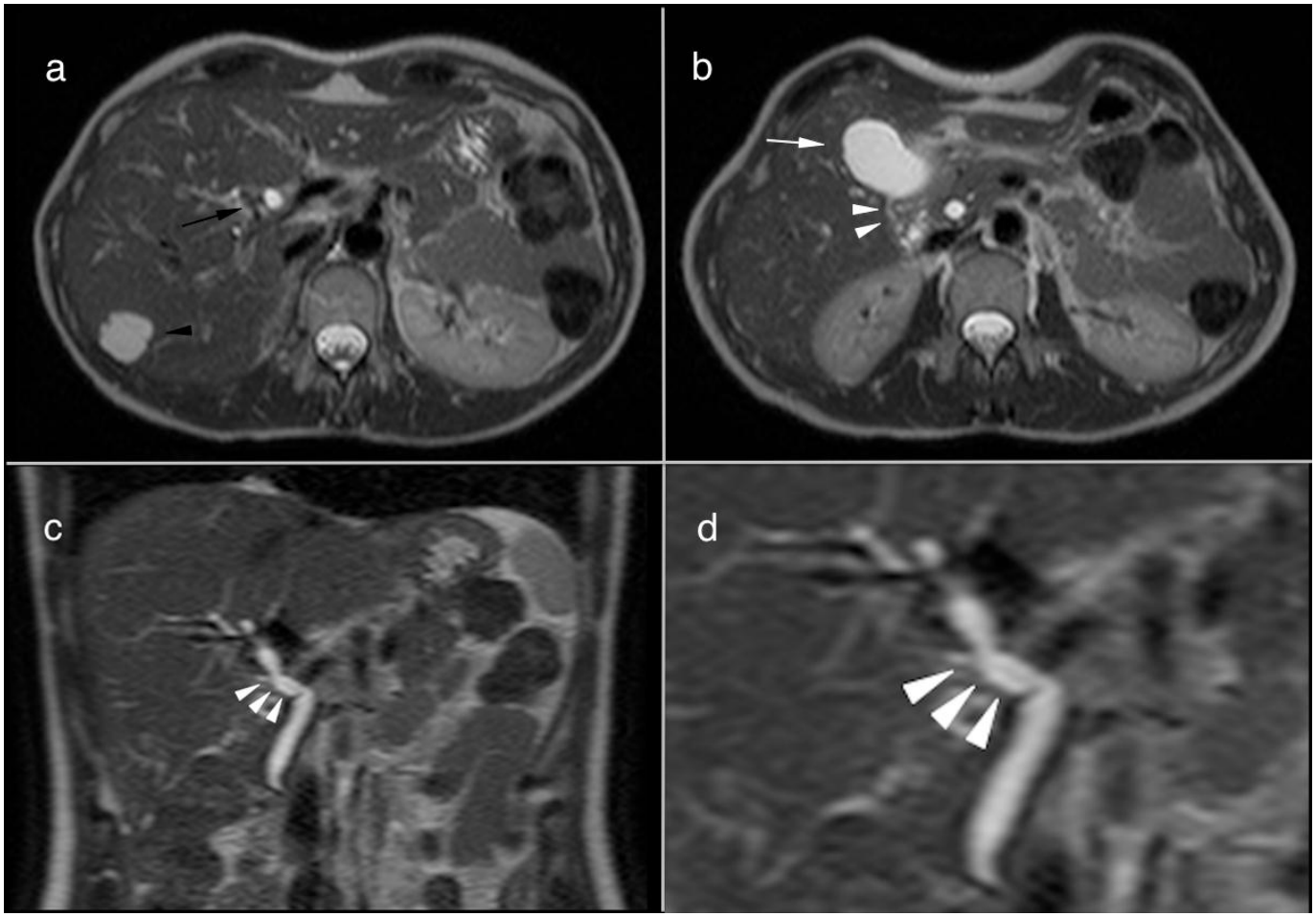

Figure 3. 42-year-old female with bile leak after laparoscopic cholecystectomy. Transverse and coronal T2-weighted fast spin echo abdominal images. (a) Scan obtained at the hepatic hilum confirms the findings previously noted at CT (status post-cholecystectomy, black arrow, and liver hemangioma, black arrowhead). (b, c, d) There is a 2.6 x 5.7 x 2.6 cm ovoid thin-walled fluid collection with high signal intensity on T2WI located in the gallbladder fossa (white arrow); a small connection between the fluid collection and the cystic duct remnant is depicted (white arrowheads).
(1.5 T Philips; Protocol: TR 553 ms, 80 TE ms, 3 mm thickness)

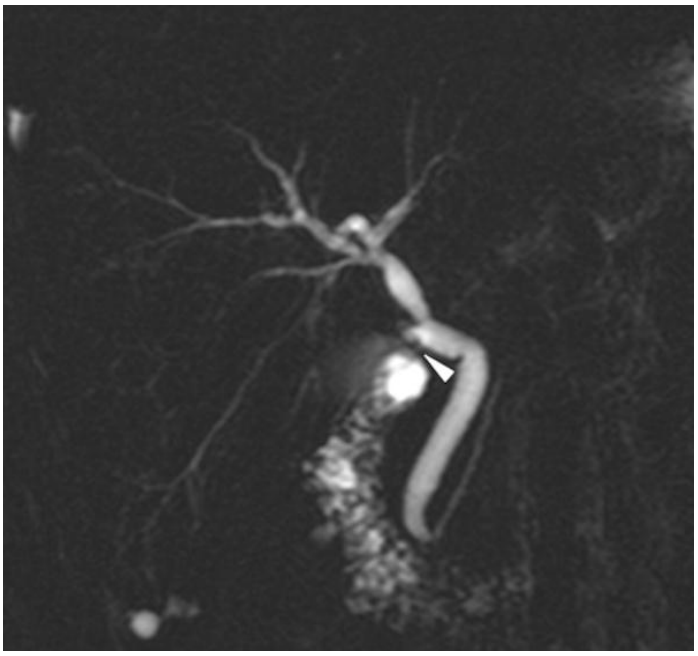

Figure 4 (left). 42-year-old female with bile leak after laparoscopic cholecystectomy. Thick-slab heavily T2-weighted MRCP. The small connection is again demonstrated (white arrowhead).
(1.5 T Philips; Protocol: TR 8000 ms, TE 800 ms, 70 mm thickness)

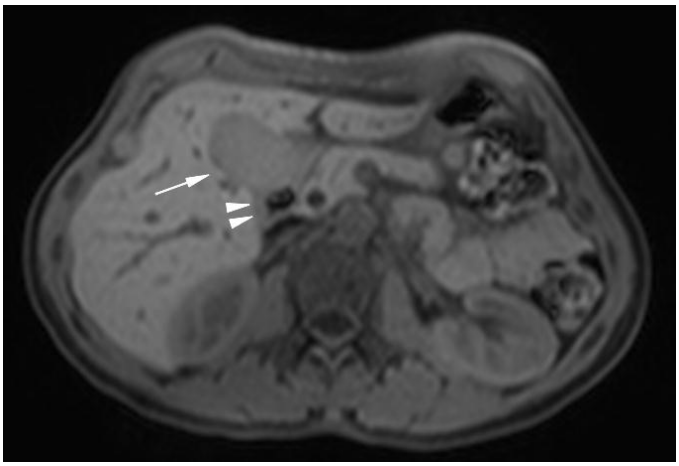

Figure 5 (left). 42-year-old female with bile leak after laparoscopic cholecystectomy. Transverse T1-weighted breath-hold gradient-echo abdominal MR scans. Previously described fluid collection (white arrow) has medium signal intensity and is compatible with biloma.
(1.5 T Philips; Protocol: TR 242 ms, TE 4 ms, 5 mm thickness)

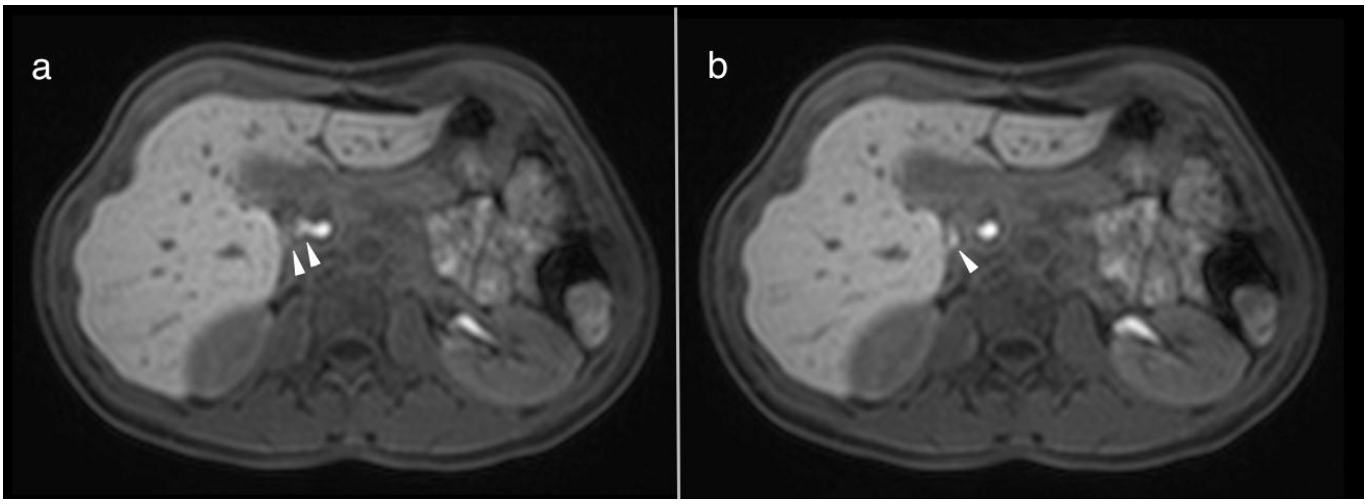

Figure 6 (a,b). 42-year-old female with bile leak after laparoscopic cholecystectomy. Transverse T1-weighted breath-hold gradient-echo abdominal MR scans obtained during hepatobiliary phase after 20 minutes from intravenous administration of 0.025 mmol per kilogram of body weight of Gd-EOB-DTPA. Minimal passage of contrast material (white arrowheads) is seen from the cystic duct remnant.
(1.5 T Philips; Protocol: T1w-GE 3D, TR 3.53 ms, TE 1.68 ms, 4 mm thickness)

Etiology	Mainly caused by slipped cystic duct ligature or leak from an accessory or anomalous bile duct
Incidence	Significant postoperative bile leak may occur in up to 1% of patients undergoing laparoscopic cholecystectomy compared to 0.5% in open cholecystectomy
Gender ratio	There is no gender predominance
Age predilection	There is no age predilection
Risk factors	Presence of an accessory or anomalous bile duct
Treatment	Bile leak without significant major duct injury: percutaneous external drainage of the biloma, ERCP with sphincterotomy, or placement of temporary stent may be necessary. Bile leak with major bile duct injury: surgical biliary reconstruction
Prognosis	Complete recover if promptly diagnosed and treated
Findings on imaging	Bile collection mainly located in the gallbladder fossa; small connection with the cystic duct remnant usually visible on MRCP and on MRI during hepatobiliary phase after intravenous administration of liver-specific contrast agents

Table 1: Summary table of postoperative bile leak

Entity	US	CT	MR	Scintigraphy
Bile leak	Anechoic slightly heterogeneous collection with some echogenic spots	Water-density thin-walled fluid collection	• Thin-walled fluid collection; • *T2WI:* high signal; • *T1WI:* medium to low signal (signal intensity of bile) • *MRCP:* Connection between the collection and the cystic duct remnant • *T1WI post contrast:* leakage of liver-specific contrast agent during hepatobiliary excretion phase	TC-99m IDA: visualization of tracer leakage
Inflammatory post-operative fluid collection	Heterogenous collection, mainly anechoic, with echogenic spots and debris	Water-density thick-walled fluid collection	• Thick-walled fluid collection; • *T2WI:* high signal; • *T1WI:* medium to low signal	No evidence of leak
Lymphatic/serous post-operative collection	Anechoic homogeneous collection	Water-density thin-walled fluid collection	• Thin-walled fluid collection; • *T2WI:* high signal; • *T1WI:* low signal	No evidence of leak
Mild ascites due to other medical problem	Anechoic homogeneous collection	Water-density fluid collection	• Fluid collection; • *T2WI:* high signal; • *T1WI:* low signal	No evidence of leak

Table 2: Differential diagnosis table of postoperative bile leak

Type	Criteria
1	Low common hepatic duct (CHD) stricture/injury, length of CHD stump ≥ 2 cm.
2	Proximal CHD stricture/injury, CHD stump < 2 cm.
3	Hilar stricture/injury, no residual CHD but the hepatic ductal confluence is preserved
4	Hilar stricture/injury, with involvement of confluence and loss of communication between right and left hepatic duct
5	Involvement of aberrant right hepatic duct alone or concomitantly with CHD

Table 3: Bismuth classification of Bile Duct Injury

Type	Criteria
A	Leak from cystic duct or bile duct of Luschka
B	Occlusion of aberrant right hepatic duct
C	Transection without ligation of aberrant right hepatic duct
D	Lateral injury to major bile duct
E	Subdivided per the Bismuth classification into E1–E5

Table 4: Strasberg Classification of Bile Duct Injury

ABBREVIATIONS

CHD: common hepatic duct
CRP: C-reactive protein
CT: computed tomography
ERCP: endoscopic retrograde cholangiopancreatography
ESR: erythrocyte sedimentation rate
MR: magnetic resonance
MRCP: magnetic resonance cholangiopancreatography
PTC: percutaneous transhepatic cholangiography
RUQ: right upper quadrant

KEYWORDS

Laparoscopic cholecystectomy; bile leak; MR imaging; MR cholangiopancreatography; hepatobiliary contrast agents

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