

CASE REPORT

Case-based illustrative series of hepatobiliary scintigraphy in biliary disorders

Pegah Sahafi¹, Mohammad Hadi Samadi¹, Haniye Elahifard¹, Emran Askari¹, Seyed Amir Shahvarani², Ramin Sadeghi¹

¹Nuclear Medicine Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

²Surgical Oncology Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

Corresponding Author:

Dr. Ramin Sadeghi

Address: Nuclear Medicine Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.

Email: sadeghir@mums.ac.ir

Running title: Pearls and pitfalls in hepatobiliary scintigraphy

Article History:

Received: 27 February 2026

Revised: 12 June 2026

Accepted: 16 June 2026

Published Online: 01 August 2026

ABSTRACT

Hepatobiliary scintigraphy continues to play a central role in nuclear medicine, serving as an essential tool for evaluating bile flow and diagnosing a wide variety of conditions that affect the biliary system. This imaging technique remains invaluable because it provides functional as well as anatomical information, allowing clinicians to assess both normal physiology and pathologic changes. The atlas highlights classic diagnostic patterns while also drawing attention to potential pitfalls that can complicate interpretation. A wide spectrum of disorders can be evaluated with hepatobiliary scintigraphy, including acute and chronic cholecystitis, bile leaks following surgery, choledochal cysts, and a range of postoperative complications. By presenting real clinical examples, the atlas demonstrates how integrating patient history with advanced imaging approaches such as SPECT/CT can significantly improve diagnostic confidence. Successful interpretation requires meticulous attention to subtle imaging findings, a thorough understanding of hepatobiliary anatomy, and consideration of the patient's surgical history to ensure an accurate diagnosis and the best possible care.

Keywords: HIDA scan; Cholescintigraphy; Nuclear medicine; Biliary perforation; SPECT/CT

INTRODUCTION

Hepatobiliary scintigraphy, commonly known as a HIDA scan, is an imaging technique used to evaluate how the liver, gallbladder, and bile ducts are functioning. In this type of imaging, the

injected radiotracer is taken up in a manner analogous to that of bilirubin, although it is neither conjugated nor metabolized [1]. The radiotracer, is taken up by the hepatic cells, and then passes into the gallbladder, bile ducts, and eventually the small intestine. In most cases, these steps are visible within 10 to 20 minutes, though in some patients it may take up to an hour [2].

Interpreting HIDA scans can be challenging. This guide focuses on common patterns and highlights findings associated with conditions such as cholecystitis, bile leaks, and postoperative complications [3-11]. This atlas demonstrates how combining scan results with the patient's medical history and sometimes SPECT/CT imaging can improve diagnostic accuracy.

CASE SERIES PRESENTATION

This retrospective educational case series includes hepatobiliary scintigraphy studies performed at our institution. Cases were purposively selected to illustrate both classic imaging patterns and potential diagnostic pitfalls encountered in routine clinical practice. Clinical records, imaging findings, and follow-up data were reviewed to confirm the final diagnoses.

All patients received an intravenous injection of [^{99m}Tc]Tc-BRIDA, followed by dynamic imaging. Additional delayed views and SPECT/CT acquisitions were obtained when indicated to clarify findings or localize abnormal tracer activity.

Case 1 (Figure 1)

A patient undergoing hepatobiliary scintigraphy for assessment of gallbladder ejection fraction demonstrated normal tracer uptake by the liver, prompt visualization of the gallbladder and common bile duct, and normal passage of radiotracer into the small bowel. Gallbladder visualization was evident by 10 minutes after radiotracer administration (blue arrow), while bowel activity was observed by 15 minutes (yellow arrow). These findings represent normal hepatobiliary function with patent biliary drainage pathways.

Teaching point: Normal hepatobiliary transit is characterized by prompt hepatic uptake, rapid clearance of cardiac blood-pool activity, visualization of the gallbladder within 30–60 minutes, and visualization of the small bowel within 60 minutes (occasionally up to 90 minutes) after radiotracer injection. These findings confirm normal hepatobiliary function and patency of both the cystic duct and common bile duct.

Case 2 (Figure 2)

One of the key indications for HIDA scanning is the evaluation of suspected cholecystitis. Three patients with abdominal pain were referred for this purpose. Careful attention must be given to gallbladder filling, and potential mimickers, such as duodenal activity, should be excluded using additional right lateral and left anterior oblique views [12]. Persistent non-visualization of the gallbladder (red arrows), even on delayed images, confirmed by SPECT/CT, is diagnostic for acute cholecystitis (Figure 2A).

In contrast, gallbladder activity observed within 1 hour, with confirmation on SPECT/CT (blue arrows), rules out acute cholecystitis and indicates a patent cystic duct (Figure 2B).

Concurrent filling of the gallbladder and a sentinel bowel loop (green arrows) requires careful interpretation to avoid misdiagnosis, since bowel activity may mimic gallbladder uptake (Figure 2C).

Teaching point: Accurate identification of non-filling the gallbladder is essential in suspected acute cholecystitis, and additional projections or SPECT/CT may help differentiate true gallbladder visualization from adjacent bowel activity.

Case 3 (Figure 3)

For choledochal cysts, HIDA scanning has high sensitivity—particularly for type I—but is generally reserved as a second-line test when ultrasound findings are inconclusive [13]. In this case, a patient with ascites and a suspected choledochal cyst on CT underwent hepatobiliary scintigraphy. No tracer activity was observed within the cystic lesion on dynamic, delayed, or SPECT/CT images (arrows), thereby excluding communication with the biliary system, ruling out a choledochal cyst. Interpretation of this case was limited by impaired hepatic clearance and reduced biliary excretion, highlighting one of the known limitations of hepatobiliary scintigraphy.

Teaching point: Lack of radiotracer accumulation within a cystic lesion effectively excludes communication with the biliary tree and can help differentiate non-biliary cystic lesions from choledochal cysts.

Case 4 (Figure 4)

Detection of bile leaks after surgery is another important application of HIDA scans. In a patient with recent cholecystectomy, minimal tracer accumulation was observed in the gallbladder bed (black and white arrows), with concurrent tracer passage into the bowel suggesting low-pressure biliary leak (Figure 4A and Supplementary video 1).

A patient with recent liver transplantation, localized tracer pooling was seen in the inferior portion of the liver (blue arrow), along with bowel activity, indicating a low-pressure bile leak that resolved without intervention (Figure 4B and Supplementary video 2).

Teaching point: Simultaneous visualization of tracer leakage and bowel activity is characteristic of a low-pressure bile leak and often indicates preserved biliary drainage.

Case 5 (Figure 5)

Distinguishing low-pressure from high-pressure bile leaks is crucial, as high-pressure leaks require urgent reoperation, whereas low-pressure leaks may be managed conservatively.

In a patient with recent cholecystectomy, tracer accumulation in the gallbladder bed (arrow) and drainage through an external tube (arrowhead) without bowel visualization confirmed a significant bile leak (Figure 5A and Supplementary video 3).

In another patient with prior hepatojejunostomy, the absence of radiotracer entry into the bowel loop indicated anastomotic failure (Figure 5B).

In a patient with recent liver transplantation, no tracer passage into the bowel was observed, suggesting a high-pressure biliary leak (Figure 5C).

Teaching point: Absence of radiotracer passage into the bowel in the presence of tracer extravasation suggests a high-pressure biliary leak requiring prompt clinical attention.

Case 6 (Figure 6)

A patient with history of hepatojejunostomy underwent HIDA scintigraphy with dynamic acquisition at 300 sec/frame. HIDA scanning revealed no tracer extravasation into the peritoneal cavity or surgical bed, effectively excluding a bile leak. The observed fluid collection (arrows) was consistent with a postoperative seroma. Tracer accumulation along the inferior aspect of the liver corresponded to physiologic activity within the hepatojejunostomy bowel loop. The presence of intraluminal bowel gas on the corresponding CT images helped differentiate the bowel activity from the adjacent postoperative seroma.

Teaching point: A postoperative fluid collection that demonstrates no radiotracer uptake on hepatobiliary scintigraphy is unlikely to communicate with the biliary tree. This finding helps

differentiate a postoperative seroma from a bile leak, in which progressive radiotracer accumulation would be expected within the collection.

Case 7 (Figure 7)

A patient evaluated for chronic cholecystitis underwent hepatobiliary scintigraphy after consuming a fatty meal containing 10 grams of fat (Figure 7A). The imaging revealed a low gallbladder ejection fraction (less than 35%). Following cholecystectomy, repeat scintigraphy (Figure 7B) confirmed the presence of a biliary leak, demonstrated by radiotracer extravasation into the peritoneal cavity (arrows).

Teaching point: Hepatobiliary scintigraphy is a versatile imaging modality that can be used both to assess gallbladder contractility and to detect postoperative bile leaks, providing important functional information that may not be available with anatomic imaging alone.

Case 8 (Figure 8)

A patient without surgical history who presented with abdominal pain. The gallbladder was not seen even on delayed imaging, which was consistent with chronic cholecystitis. Increased tracer uptake in the left upper quadrant (black arrow) represented biliary reflux into the stomach, confirmed with anatomic correlation (Figure 8A).

Another patient with recent history of surgery. The scan showed similar uptake in the same region of the left upper quadrant (blue arrow) corresponding to biliary leakage (Figure 8B). These two cases underscore the importance of surgical history in distinguishing gastric biliary reflux from bile leakage and highlight the value of SPECT/CT for precise localization of abnormal uptake.

Teaching point: Abnormal radiotracer activity in the left upper quadrant may represent gastric biliary reflux or bile leakage; correlation with surgical history and SPECT/CT localization is crucial for accurate diagnosis.

Case 9 (Figure 9)

A 2-month-old infant presented with unexplained ascites. Hepatobiliary scintigraphy suggested spontaneous bile duct perforation, SPECT/CT demonstrated radiotracer activity in the ascitic fluid as well as in the bowel (arrow). The first surgery found an intact hepatobiliary system. A second operation for worsening ascites revealed congestive hepatopathy and a bile leak from the liver surface, consistent with the “crying liver” phenomenon.

Teaching point: The presence of radiotracer within ascitic fluid does not always indicate biliary tract perforation. Careful assessment of tracer distribution, bowel activity, and SPECT/CT findings is essential to avoid misdiagnosis and unnecessary surgical intervention.

DISCUSSION

Hepatobiliary scintigraphy is a functional imaging technique widely used in the assessment of biliary tract disorders. It enables evaluation of conditions such as acute cholecystitis, biliary dyskinesia, bile leakage, and biliary atresia. The method is generally safe, well tolerated, relatively inexpensive, and associated with low radiation exposure, which makes it applicable in both pediatric and adult populations [1, 2]. In comparison with ultrasound, CT, and MRI, it provides unique physiological information about bile production and excretion, often allowing earlier detection of functional abnormalities before structural changes become evident. The diagnostic performance can be enhanced by additional imaging projections or the use of SPECT/CT, which helps reduce interpretive errors [12-14].

Despite these advantages, HIDA scanning has important limitations. It offers limited anatomical detail and has reduced sensitivity in identifying biliary obstruction or strictures. False-positive results may occur, particularly in patients receiving medications such as opioids. In conditions like severe cholestasis or marked hyperbilirubinemia, tracer uptake and excretion may be significantly impaired, reducing diagnostic reliability. Nevertheless, it remains highly sensitive for detecting bile leaks and continues to play a key role in the functional assessment of the biliary system [12, 13].

Limitations

This educational case series has several limitations. Cases were selectively chosen for teaching purposes and do not represent a consecutive patient population. Additionally, histopathological confirmation was not available for every case, and some diagnoses relied on clinical and imaging follow-up.

CONCLUSION

Although hepatobiliary scan is not usually the first-line imaging technique, this technique becomes particularly valuable when other modalities yield inconclusive results. It has proven consistently effective in detecting acute and chronic cholecystitis, differentiating types of bile duct obstruction, and identifying bile leaks following surgery. For these reasons, hepatobiliary scintigraphy remains an essential tool in the comprehensive assessment of biliary pathology.

REFERENCES

1. Kobayashi M, Nakanishi T, Nishi K, Higaki Y, Okudaira H, Ono M, Tsujiuchi T, Mizutani A, Nishii R, Tamai I, Arano Y, Kawai K. Transport mechanisms of hepatic uptake and bile excretion in clinical hepatobiliary scintigraphy with 99mTc-N-pyridoxyl-5-methyltryptophan. Nucl Med Biol. 2014 Apr;41(4):338-42.
2. Lambie H, Cook AM, Scarsbrook AF, Lodge JP, Robinson PJ, Chowdhury FU. Tc99m-hepatobiliary iminodiacetic acid (HIDA) scintigraphy in clinical practice. Clin Radiol. 2011 Nov;66(11):1094-105
3. Joodi M, Norouzbeigi N, Rad MA, Shojaeian R, Kakhki VR, Sadeghi R. Spontaneous perforation of common bile duct in a pediatric patient: application of hepatobiliary scintigraphy. Clin Nucl Med. 2012 Oct;37(10):1006-8.
4. Won KY, Kim C. Bicastral gallbladder with chronic cholecystitis on hepatobiliary scintigraphy. Clin Nucl Med. 2021 Jan;46(1):78-80.
5. Iyalomhe O, Rowe SP. A single gallbladder fold creates a unique visual and temporal pattern of radiotracer accumulation on hepatobiliary scintigraphy. Clin Nucl Med. 2022 Dec 1;47(12):1084-6.
6. Sánchez-Vera Y, Aguilera-Hernández E, Cardoza-Ochoa DR, González-Díaz JI. Diagnosis of traumatic bronchobiliary fistula with late 99m Tc-Mebrofenin SPECT/CT. Clin Nucl Med. 2022 Dec 1;47(12):e752-3.
7. Barashki S, Mohammadzadeh Kosari H, Askari E, Bakhshi Golestani Z, Hiraifar M, Sadeghi R. A crying liver: a scan pattern mimicking spontaneous perforation of the biliary ducts. Nucl Med Rev Cent East Eur. 2022;25(2):131-3.

8. Bai X, Zhuang H. Ectopic gallbladder in the left upper abdomen shown on hepatobiliary scintigraphy. Clin Nucl Med. 2022 Aug 1;47(8):744-5.
9. Flynt L, Grant P, Seitz JP, Qing F. Hepatobiliary scintigraphy of evolving spontaneous biliary leak. Clin Nucl Med. 2015 Jul;40(7):592-5.
10. Zhang L, Gaballah M, Wen Z, Zhuang H. Ectopic gallbladder mimicking choledochal cyst on hepatobiliary scintigraphy. Clin Nucl Med. 2020 Jun;45(6):471-3.
11. Philip JT, Noor M, Leyva A, Contreras F. Hepatobiliary scintigraphy in cholecystocolonic fistula. Clin Nucl Med. 2020 Aug;45(8):626-7.
12. Kalimi R, Gecelter GR, Caplin D, Brickman M, Tronco GT, Love C, Yao J, Simms HH, Marini CP. Diagnosis of acute cholecystitis: sensitivity of sonography, cholescintigraphy, and combined sonography-cholescintigraphy. J Am Coll Surg. 2001 Dec;193(6):609-13.
13. Mukhopadhyay B, Shukla RM, Mukhopadhyay M, Mandal KC, Mukherjee PP, Roy D, Biswas SK, Basu KS. Choledochal cyst: A review of 79 cases and the role of hepaticoduodenostomy. J Indian Assoc Pediatr Surg. 2011 Apr;16(2):54-7.
14. Tann M. Dynamic SPECT/CT HIDA imaging, an improved technique for quantitative liver function?. J Nucl Med. 2019 May;60(supplement 1):367.

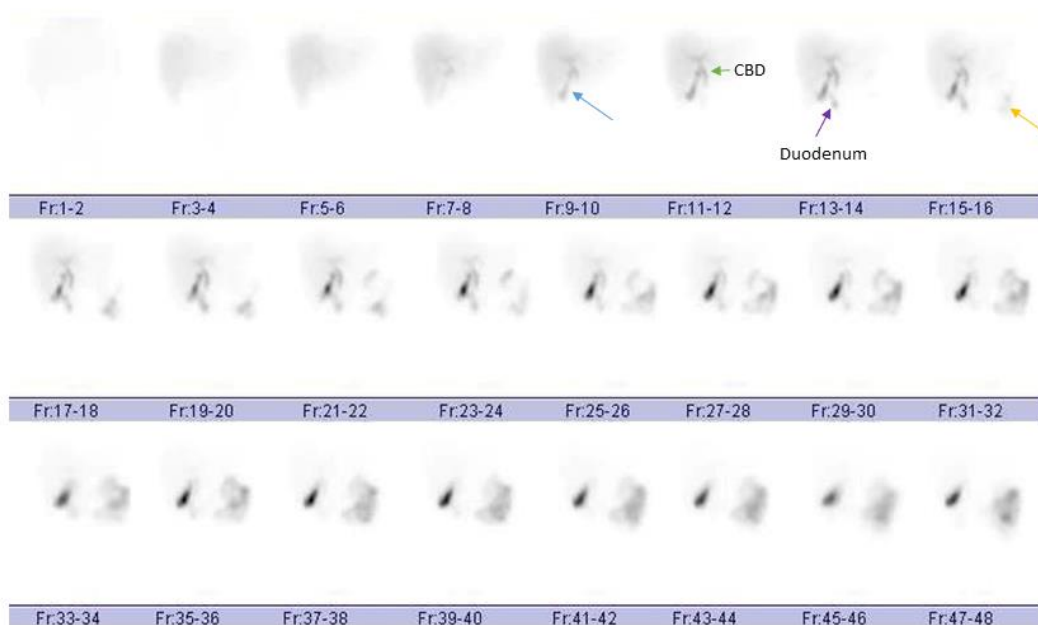


Figure 1. Normal hepatobiliary scan

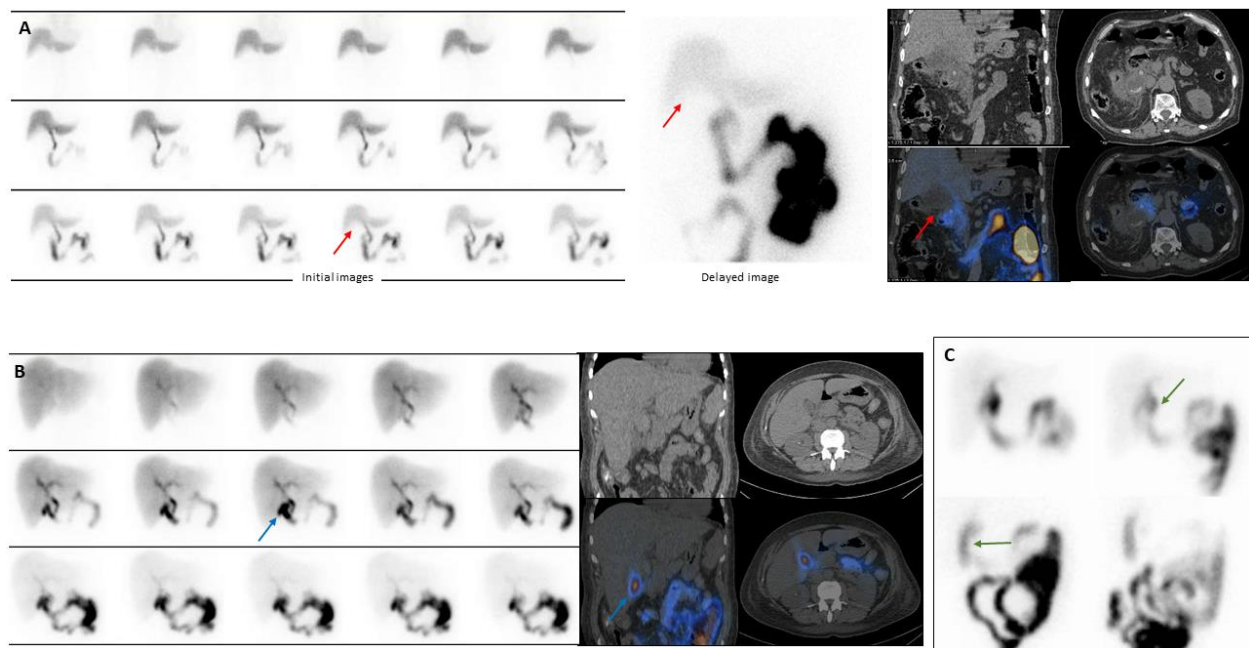


Figure 2. Non-visualization of the gallbladder suggests acute cholecystitis (A). Early filling of gallbladder excludes acute cholecystitis (B). Bowel activity can mimic gallbladder visualization (C)

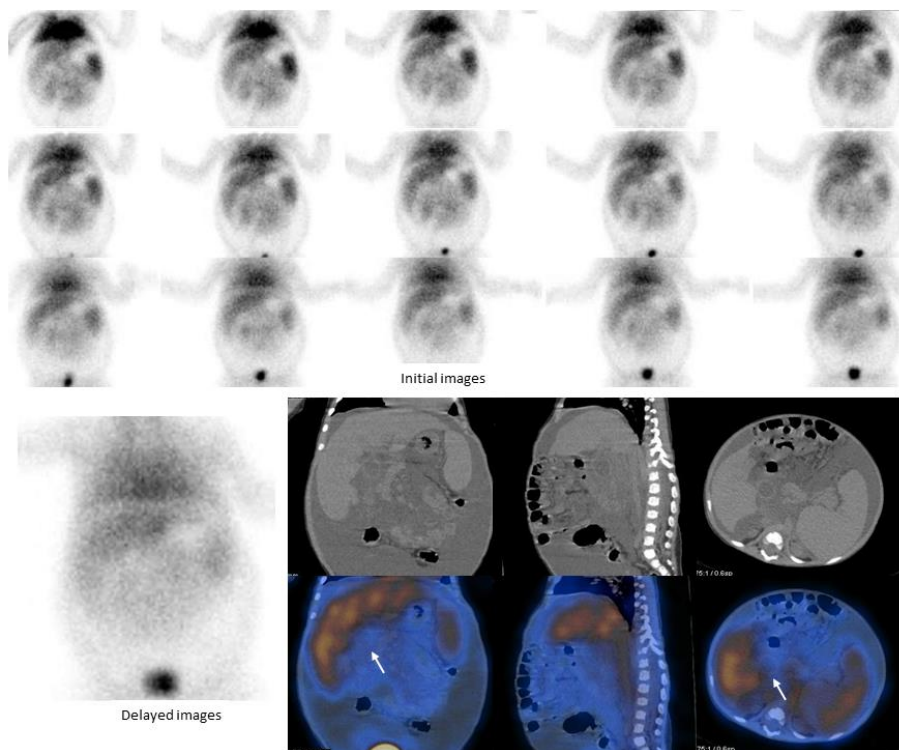


Figure 3. No abnormal tracer uptake in biliary tree rules out choledochal cyst

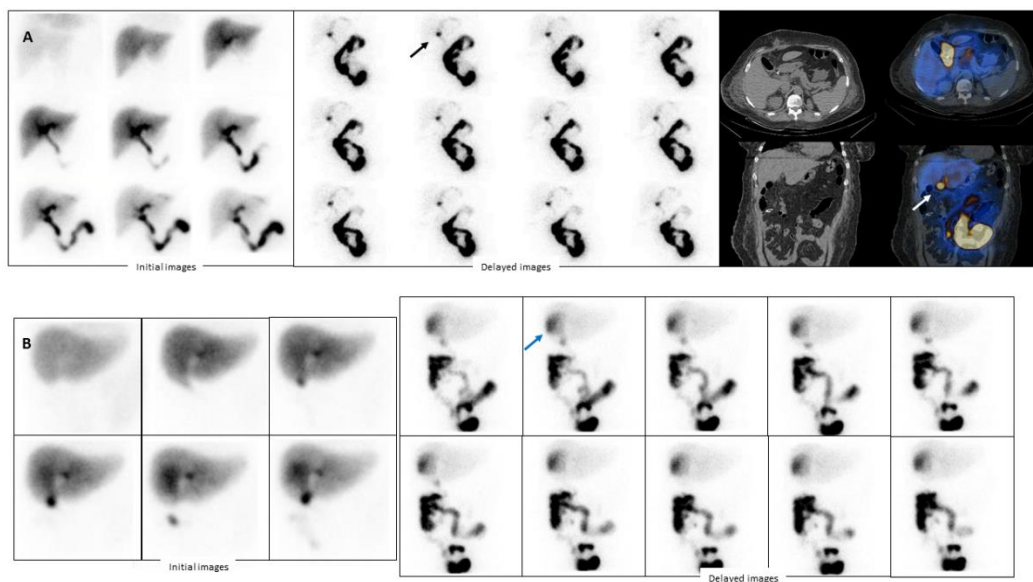


Figure 4. Minimal activity in the gallbladder bed with tracer entering the bowel indicates low-pressure obstruction (A). Tracer uptake in both the gallbladder bed and bowel suggests post-transplant bile leak (B)

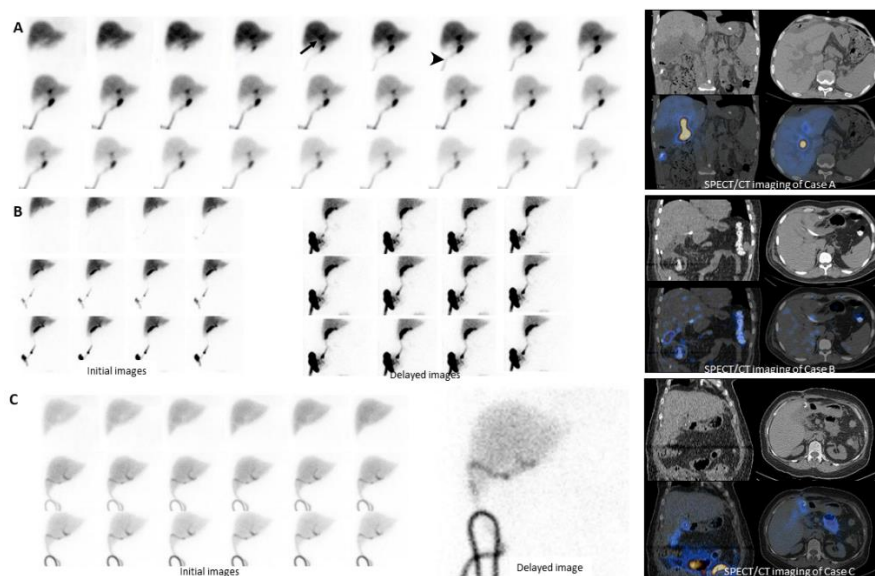


Figure 5. Absence of bowel activity indicates high-pressure biliary leak in all three patients (A-C). Tracer is also seen in the drainage tubes (arrowhead)

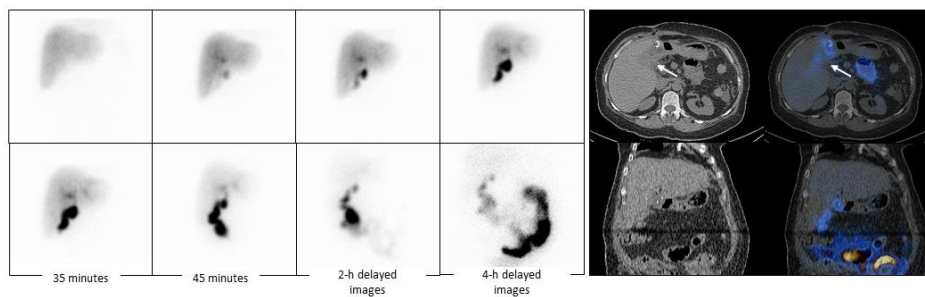


Figure 6. Fluid collection in the gallbladder bed with minimal tracer uptake is consistent with a seroma

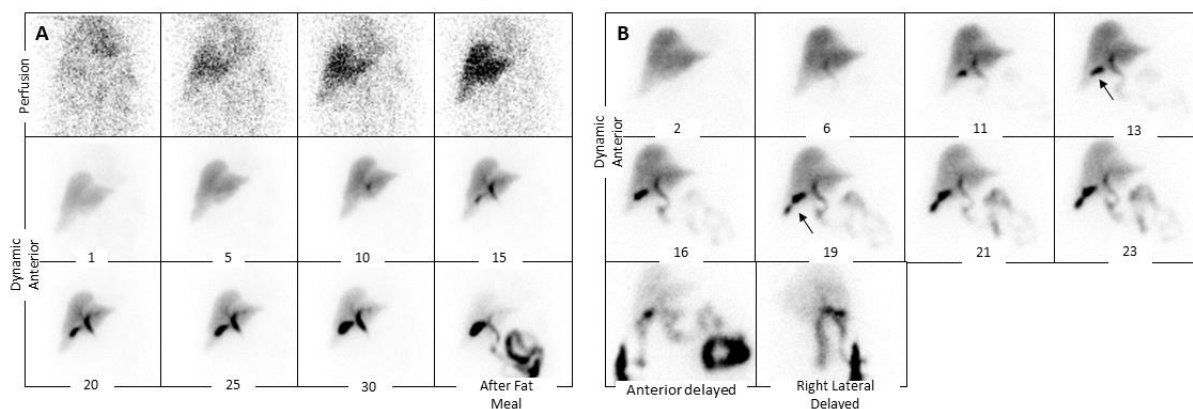


Figure 7. Patient before (A) and after cholecystectomy (B). Low gallbladder ejection fraction indicates chronic cholecystitis (A). Tracer leakage into the peritoneum demonstrates biliary leak (B)

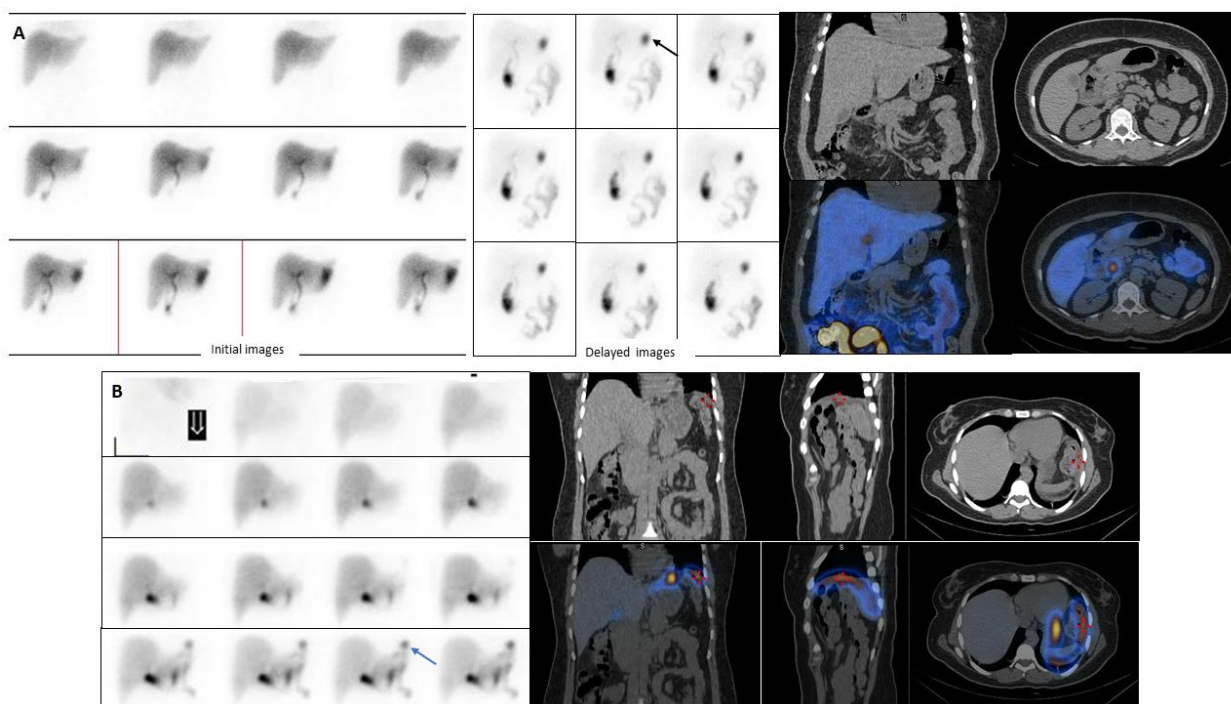


Figure 8. Chronic cholecystitis with biliary reflux into the stomach (A). Similar tracer uptake in the left upper quadrant after cholecystectomy indicates a biliary leak (B)

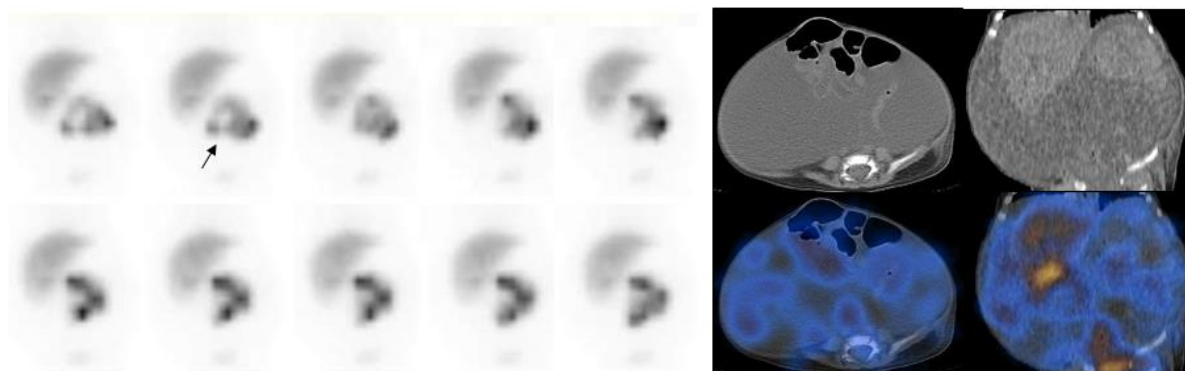


Figure 9. Unexplained ascites in a 2-month-old shows mild tracer accumulation in ascitic fluid, consistent with a bile leak from the liver surface