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Pearls and pitfalls of bile duct injury during laparoscopic cholecystectomy: A case report of the importance of preoperative detection of situs inversus totalis

Muhammad Afifudin[1*], Tety Ratna Meindhani[2], Edwin Danardono[3]
[1,2]Genereal Surgery Resident, Faculty of Medicine, Airlangga University/ Dr. Soetomo General Hospital Surabaya, Indonesia; afifudinmuhammad191191@gmail.com (M.A.).
[3]Senior Digestive Surgery Staff, Department of Surgery, Faculty of Medicine, Airlangga University/ Dr. Soetomo General Hospital Surabaya, Indonesia.

Abstract: Situs inversus totalis is a rare congenital condition characterized by mirror-image organ transposition, which complicates laparoscopic cholecystectomy due to reversed anatomy. This case report highlights the importance of recognizing situs inversus totalis before surgery to prevent pitfalls. It discusses the surgical management of a patient with situs inversus undergoing cholecystectomy for cholelithiasis, addressing the procedural adaptations required and the resulting clinical outcomes. A 48-year-old woman with cholelithiasis, without cholecystitis, presented with recurrent right upper abdominal pain. Imaging confirmed gallstones, and laparoscopic cholecystectomy was planned. Intraoperatively, situs inversus totalis was discovered, complicating the procedure. A bile duct injury occurred, necessitating conversion to open surgery with hepaticojejunostomy. Postoperatively, the patient recovered uneventfully, with no complications. Situs inversus totalis complicates surgeries like laparoscopic cholecystectomy due to reversed organ positioning. Failure to recognize it preoperatively can lead to complications, such as bile duct injury. Proper imaging, surgical adaptation, and intraoperative cholangiography are crucial for successful outcomes in patients with such anatomical variations.

Keywords: *Cholelitiasis, Laparoscopic cholecystectomy, Situs inversus totalis.*

1. Introduction

Situs inversus totalis is a rare congenital condition in which the thoracic and abdominal organs are arranged in a mirror-image reversal of their normal anatomical positions. The incidence of this anomaly is approximately 1 in 10,000–20,000 live births. Frequency of situs inversus is 1:10,000 and is more frequent in males: 1.5:1 [1]. Transposition of the organs may also affect thoracic organs, besides abdominal organs. It can be associated with Kartegener triad (bronchietasis, sinusitis, and situs inversus) and cardiac anomalies. There is no evidence for increased incidence of cholelithiasis in SIT [2]. While most individuals with situs inversus totalis are asymptomatic and unaware of their condition, the mirrored arrangement of internal organs poses unique challenges for diagnostic procedures and surgeries [3] especially in laparoscopic interventions where anatomical familiarity is crucial [4].

Cholelithiasis, or the formation of gallstones, is a common condition affecting approximately 10-15% of the adult population worldwide [5]. The standard treatment for symptomatic cholelithiasis is laparoscopic cholecystectomy, which has become the procedure of choice due to its minimally invasive nature and favorable recovery outcomes. However, in patients with situs inversus totalis, the reversed anatomical layout requires surgeons to adapt their approach. The gallbladder, typically located in the

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* Correspondence: afifudinmuhammad191191@gmail.com

right upper quadrant of the abdomen, is found in the left upper quadrant in these patients. This anatomical variation can complicate orientation, trocar placement, and instrument manipulation during laparoscopic surgery [6].

Bile duct injury typically involves damage to the biliary tree during dissection or clipping of the cystic duct. Such injuries can lead to various complications, including bile leakage, which may present as bile peritonitis or localized abscesses. Strictures or complete obstruction of the bile ducts can lead to prolonged jaundice, cholangitis, or liver dysfunction [7]. The prevalence of cutting errors in laparoscopic cholecystectomy ranges from 0.3% to 0.6%. This error occurs most often in the choledochal duct and hepatic duct because they are in an area very close to the site of the dissection procedure, namely Calot's triangle. Injury to the choledochal duct occurs in approximately 0.1% to 0.3% of all laparoscopic cholecystectomy cases. This error can result in bile leakage and require additional surgical repair. Injury to the hepatic duct (especially the right and left hepatic duct) occurs in approximately 0.1% to 0.2% of cases. Injuries to these ducts are often more complex and can result in stricture or obstruction [8, 9].

The pathophysiology of situs inversus totalis involves a disruption in the normal embryological development of the left-right axis, leading to complete transposition of the internal organs. Despite this reversal, organ function is typically unaffected [10]. However, in cases requiring surgery, such as for cholelithiasis, the condition can significantly increase the technical complexity of the procedure. Several cases have been reported in patients with situs inversus totalis. Laparoscopic cholecystectomy in these patients is technically more demanding and needs reorientation of visual-motor skills to the left upper quadrant. Without preoperative recognition of SIT, surgeons may face disorientation and inadvertently increase the risk of bile duct injury, especially during critical steps such as dissection of the Calot's triangle and the identification of biliary structures [11]The preoperative detection of SIT is therefore crucial in minimizing the risks associated with laparoscopic cholecystectomy. Failure to identify this condition can lead to pitfalls, including difficulty in orientation, prolonged operative time, and an increased likelihood of iatrogenic injury.

The purpose of this case report is to discuss the management and surgical considerations in a patient with situs inversus totalis undergoing laparoscopic cholecystectomy for cholelithiasis without associated cholecystitis. We aim to highlight the specific challenges encountered during surgery, the necessary modifications to standard techniques, the clinical outcomes, the significance of recognizing SIT before surgery and discusses the pitfalls associated with undiagnosed SIT during laparoscopic cholecystectomy, with a focus on preventing bile duct injury.

2. Case Presentation

Mrs. SH, a 48-year-old woman, presented with a referral to our clinic due to frequent episodes of right upper abdominal pain radiating to her back for the past month. The pain was intermittent, and she also reported nausea but no vomiting or jaundice. The patient had previously undergone an abdominal ultrasound at another hospital, which revealed gallstones. She was prescribed ursodeoxycholic acid (UDCA) as a gallstone dissolvent, with initial improvement, but her symptoms recurred. She denied fever, history of jaundice, pale stools, or tea-colored urine. There was no history of weight loss, diabetes mellitus, hypertension, or heart disease. Family history was notable for gallstones in her mother and sister, who experienced similar symptoms. The patient had been taking UDCA 250 mg twice daily regularly.

The patient's vital signs were within normal limits, and her general condition was stable. On abdominal examination, percussion over the liver revealed dullness, but no other abnormalities were found. A previous abdominal ultrasound from the referring hospital showed a normal-sized gallbladder without wall thickening, cysts, or masses, but the presence of two gallstones measuring approximately 0.4 cm and 0.8 cm, consistent with cholelithiasis. A chest X-ray revealed no abnormalities in the lungs and the presence of suspicion of dextrocardia. Laboratory tests demonstrated elevated white blood cell count (16.77 × 10^3/μL), neutrophilia (85.1%), and mildly increased direct bilirubin (0.40 mg/dL).

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Based on clinical history, physical examination, and imaging, the diagnosis was Cholecystolithiasis without Cholecystitis.

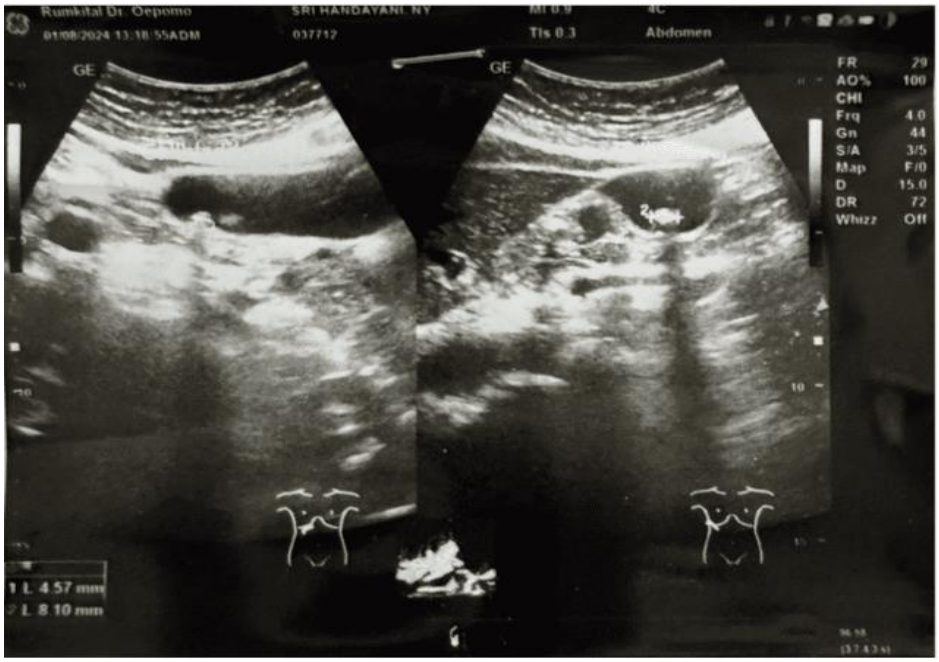

Figure 1.
Abdominal ultrasound examination.

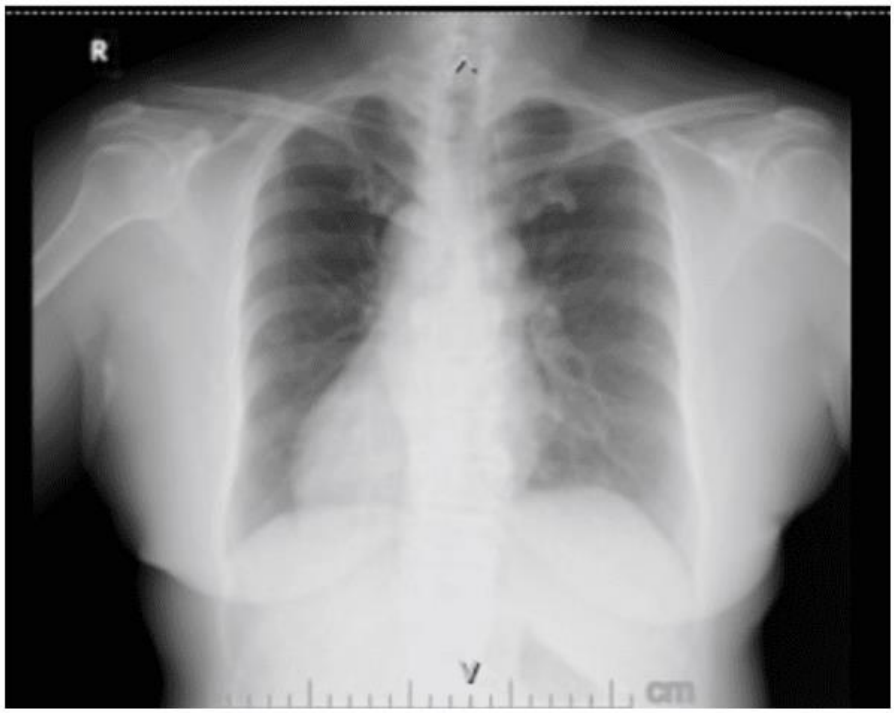

Figure 2.
Chest X Ray examination.

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Laparoscopic cholecystectomy was planned for the patient and performed by the chief general surgeon. The operation lasted 4 hours, it was found that in the medial part of the gallbladder there were two stones measuring approximately 1 cm and 3 mm. There was complete transection of the common hepatic duct below the confluence, causing a bile leak proximal to the duct, consistent with a Strasberg type E3 bile duct injury. For this reason, open bypass hepatico-jejunostomy conversion was performed. During conversion, it was identified that the liver and appendix were located on the left side, indicating the presence of situs inversus. This explains the reason for injury to the bile duct. The situs inversus was not evaluated preoperatively, which resulted in the position of the portal common bile duct structure and hepatic mirroring. The procedure begins with the installation of three laparoscopic ports, then anatomical identification is carried out through skeletonization of the cystic duct and cystic artery, followed by ligation and cutting. The gallbladder is separated from the base of the liver and removed using a special bag. Evaluation of the surgical site revealed bile leakage from the distal common hepatic duct below the confluence, so it was decided to convert the procedure to open surgery with a Kocher incision. During open surgery, it was again discovered that the internal organs such as the liver, appendix, stomach, and duodenum were on an unusual side, thus confirming the presence of situs inversus. As a corrective measure, a hepaticojejunostomy procedure was performed. Two intraductal drains and two subhepatic drains were placed to monitor and control postoperative leakage. The procedure ends with controlling bleeding and gradual closure of the wound with layer-by-layer stitches. The injury was managed, and the procedure was completed successfully. The patient had an uneventful recovery without significant post-operative pain. Follow-up over several days showed good progress, with no additional complications.

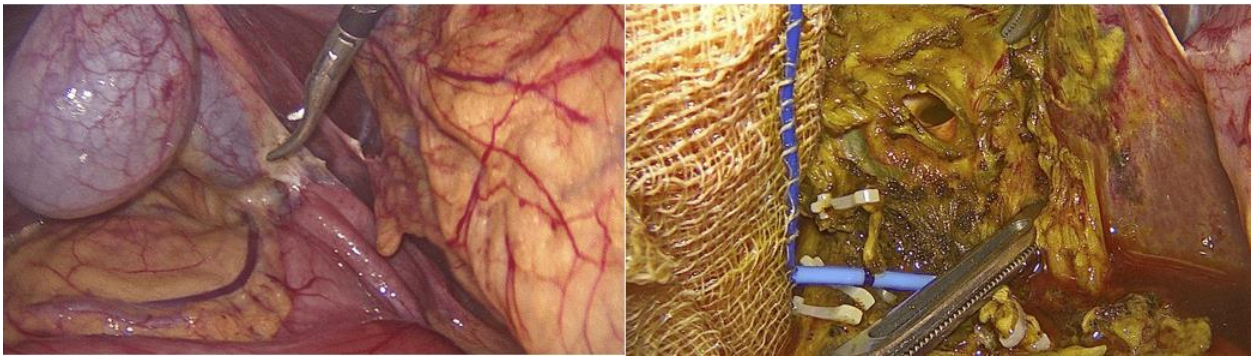

Figure 3.
Laparoscopic cholecystectomy.

3. Discussion

Situs Inversus Totalis (SIT) presents a unique challenge for surgeons, particularly during laparoscopic procedures such as cholecystectomy [12]. In this case, SIT was discovered intraoperatively, resulting in an unexpected bile duct injury. This highlights one of the most significant pitfalls of performing surgery in patients with unrecognized SIT—the altered anatomy can increase the risk of complications, particularly involving structures like the bile ducts.

Bile duct injury is a well-known complication during laparoscopic cholecystectomy. The incidence of bile duct injury increased with increasing adoption of the laparoscopic technique for cholecystectomy and treatment of other biliary pathologies. Bile duct injury occurs in 0.3 to 0.7% of the approximately 750000 laparoscopic cholecystectomies performed in the United States every year [13]. However, the risk is heightened in patients with SIT due to the reversed anatomical orientation of the liver, gallbladder, and biliary tree. The surgeon, accustomed to standard anatomy, may misidentify or incorrectly visualize critical structures. In this case, the gallbladder was situated in the left upper

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quadrant, and the biliary tree was similarly mirrored, leading to difficulty in accurately locating and dissecting the bile duct.

In patients with SIT, the gallbladder and biliary tree are located on the left side of the abdomen, opposite to their normal positions. This reversal requires the surgeon to adapt to a mirror-image view of the anatomy. The common bile duct (CBD), cystic duct, and cystic artery are all reversed, which can lead to confusion during dissection and identification of key structures [4]. In this case, the bile duct injury likely occurred during the attempt to identify and divide the cystic duct, as its position was unexpected due to the anatomical mirror-image.

Situs Inversus Totalis is a rare congenital condition, with an estimated prevalence of approximately 1 in 10,000 people. The condition is usually asymptomatic and may go undetected unless it is incidentally discovered during imaging or surgery [1]. In the context of cholelithiasis, patients with SIT may present with atypical symptoms, such as left-sided abdominal pain rather than the characteristic right-sided pain, which could lead to delayed or missed diagnosis [4].

During surgery, one critical error is failure to consider dextrocardia, which can indicate the presence of situs inversus totalis (SIT). Without recognizing this condition before surgery, the surgical team proceeded with a standard anatomical approach, which caused disorientation during the procedure. As a result, misidentification of biliary structures, such as the bile duct and gallbladder, is more likely to occur, thereby significantly increasing the risk of bile duct injury. This oversight leads to increased operative time, additional complications, and increased patient morbidity. Early recognition of dextrocardia as a potential marker of SIT may help reduce this risk. During surgery, evaluation of the position of organs such as the gallbladder and liver must be carried out before surgery to anticipate potential complications due to anatomical changes. The pre-operative time-out process should explicitly mention the presence of dextrocardia to increase the surgical team's awareness of the possibility of situs inversus, so that appropriate steps can be taken to ensure safety and reduce the risk of intra-operative complications.

Several cases also report the discovery of situs inversus in cases of Cholecystolithiasis. A case of a 10-year-old boy with a two-month history of pain in the left hypochondrium and epigastric region. The patient had not been previously diagnosed with situs inversus totalis. A left-sided positive "Murphy's sign" was noted. The diagnosis of situs inversus totalis was confirmed through ultrasound, CT scan, and MRI, revealing multiple gallstones without intra- or extra-biliary duct dilatation. The patient successfully underwent laparoscopic cholecystectomy for cholelithiasis [4]. Apart from that, other cases also reported the same thing. A 20-year-old female presented with dyspepsia and pain in her left, upper abdomen for the past five days. An abdominal ultrasound was performed and the results were obtained: 1) A gallbladder, small in size, with a thickened wall and situated on the left side. The lumen was filled with multiple, small calculi with posterior acoustic shadowing; 2) The liver situated on the left side, normal in size, with a homogenous parenchymal echo pattern. The intrahepatic biliary channels were not dilated; 3) The common bile duct was normal in size and diameter without any intraluminal lesions; 4) The spleen was normal in size and shape without any focal lesions and situated on the right side; and 5) Features were consistent with situs inversus. The electrocardiograph showed a right axis deviation while the chest x-ray (posteroanterior view) showed dextrocardia, the left hemidiaphragm slightly raised compared to the right side and a fundic gas shadow, of the stomach, on the right side, all findings consistent with situs inversus totalis. The findings were re-confirmed with a computed tomography of the abdomen and the diagnosis was established to be a case of cholelithiasis in a patient with situs inversus totalis [10]. These two cases show that it is very important for a doctor to carry out a thorough examination before carrying out surgery on a patient. Various supporting examinations such as abdominal USG and CT scan are very crucial to diagnose patients with situs inversus if suspicion is found.

In most cases, SIT can be diagnosed through imaging techniques such as abdominal ultrasound, chest X-ray, or computed tomography (CT) scans. In this case, despite a prior abdominal ultrasound, SIT was not identified. This may have been due to the ultrasound focusing on the gallbladder alone,

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without considering the orientation of other visceral organs. Preoperative chest X-rays showing dextrocardia (a hallmark of SIT) can provide clues to the diagnosis, and routine review of organ positioning on imaging is critical to avoid surprises during surgery. When SIT is not identified preoperatively, the condition is usually discovered during surgery, as in this case. Surgeons may notice the gallbladder in the left upper quadrant instead of the right. The key to avoiding complications in this scenario is for the surgeon to quickly recognize the mirrored anatomy and adjust their technique accordingly. The use of intraoperative cholangiography can help delineate the biliary anatomy, reducing the risk of injury to the bile ducts in such cases [1].

Once SIT is identified, certain adjustments must be made to ensure the success of the procedure. The surgeon must mentally reverse the anatomy and proceed with caution, especially during dissection of the Calot's triangle. Some strategies to reduce the risk of bile duct injury in patients with SIT include: Preoperative imaging: A more thorough preoperative assessment, including reviewing chest X-rays and abdominal CT scans, may help identify SIT before surgery. Magnetic resonance cholangiopancreatography (MRCP) can provide detailed images of the biliary tree and should be considered if SIT is suspected. Intraoperative cholangiography: Performing cholangiography during surgery can clarify the anatomy of the bile ducts and reduce the likelihood of injury. Adapted surgical techniques: In SIT, surgeons may need to operate from the left side of the patient or reverse the port placement to accommodate the mirrored anatomy. The use of angled scopes or modified camera positioning can help in providing better visualization of the left-sided structures [1].

4. Conclusion

Situs Inversus Totalis is a rare congenital condition that can complicate routine surgical procedures, such as laparoscopic cholecystectomy, due to the mirror-image positioning of internal organs. Failure to recognize SIT preoperatively, as in this case, can lead to unexpected complications, including bile duct injury. Proper preoperative imaging, including detailed abdominal and thoracic assessments, is essential to identify anatomical anomalies and to plan for a safer surgery. Once SIT is recognized, surgeons should adapt their techniques, considering the altered anatomy, and use intraoperative cholangiography when necessary to avoid bile duct injuries. With appropriate adjustments and careful surgical planning, successful outcomes can be achieved even in patients with challenging anatomical variations like SIT.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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