

Case Reports and Surgical Strategy Analysis of Laparoscopic Cholecystectomy for Left-Sided Gallbladder

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ABSTRACT

Left-sided gallbladder (LSG) is a rare anatomical variation of the gallbladder, often accompanied by other biliary system anomalies, and is typically discovered incidentally during laparoscopic surgery. This paper reports two cases of LSG, providing detailed descriptions of the anatomical features encountered during laparoscopic cholecystectomy, the adjustments made to patient positioning, trocar placement, and key surgical techniques. In response to intraoperative anatomical variations, the surgeries were completed safely and efficiently by optimizing surgical strategies and identifying key anatomical landmarks. Both patients had smooth postoperative recoveries without complications. This report, in conjunction with literature review, discusses the essential surgical approaches and strategies for preventing complications in LSG cases, offering valuable insights for clinicians managing such rare cases.

KEYWORDS

Left-sided gallbladder; Laparoscopic cholecystectomy; Anatomical variation; Critical view of safety; Gallbladder anomalies

1 Introduction

Left-sided gallbladder (LSG) is a rare congenital anatomical variation in which the gallbladder is located to the left of the falciform ligament and the round ligament of the liver [1, 2]. This variation was first identified by Hochstetter in 1886 during an autopsy [2, 3], with Kehre later reporting the first case during abdominal surgery in 1902 [3]. The incidence of LSG has been reported to be between 0.2% and 1.1%, though it is likely underreported [2]. Since patients usually present with symptoms similar to right-sided gallbladder diseases, preoperative diagnosis through routine imaging is often challenging, and most cases are discovered intraoperatively [1, 3, 4]. Although several hypotheses have been proposed regarding the pathogenesis of LSG, a definitive consensus has not been reached [2, 5]. Studies suggest that LSG may be associated with developmental anomalies of the liver or gallbladder, and it is frequently accompanied by variations in structures such as the portal vein and intrahepatic bile ducts [1, 2, 5]. These associated anatomical variations can increase the complexity of gallbladder removal or liver surgery and heighten the risk of complications [1, 2, 5].

With the advancement of laparoscopic techniques, the management of LSG has garnered increasing attention. Accurate intraoperative identification of the gallbladder and surrounding structures, coupled with appropriate adjustments in surgical strategies, is critical for ensuring surgical success [4]. The literature suggests that traditional right-sided trocar placement may not provide adequate exposure for LSG cases, necessitating flexible adjustments based on specific

anatomical conditions [4]. Moreover, special consideration must be given to portal vein and biliary variations during LSG surgery, especially when operating on the biliary tract [4, 5]. By presenting two cases of laparoscopic cholecystectomy for LSG, this paper analyzes key surgical considerations and strategies for managing LSG, aiming to provide valuable guidance for reducing intraoperative complications and enhancing safety and success rates in such cases.

2 Case Reports

Case 1: A 49-year-old male was admitted with a 3-week history of recurrent right upper abdominal pain. Physical examination revealed no jaundice, abdominal tenderness, or muscle guarding, and Murphy's sign was negative. His past medical history included depression, which had been in remission for 6 years with regular treatment. Routine laboratory tests, including complete blood count, liver and kidney function tests, coagulation profile, chest X-ray, and ECG, were unremarkable. Abdominal ultrasound showed a polyp-like lesion in the gallbladder with heterogeneous echogenicity at the fundus. CT imaging revealed thickening of the gallbladder wall, and MRI with MRCP suggested chronic cholecystitis with bile stasis. The imaging reports did not indicate any abnormalities in gallbladder position, but LSG was suspected during preoperative imaging review (Fig. 1A, B). Laparoscopic cholecystectomy was scheduled, and intraoperatively, the gallbladder was found to be positioned to the left of the falciform ligament, with the gallbladder infundibulum crossing the hepatic hilum anteriorly (Fig. 1C). The anatomy of the cystic duct and artery was consistent with that of a typical right-sided gallbladder (Fig. 1D). The surgeon adjusted the trocar placement and positioned the patient in a head-up, right-tilted position. The assistant retracted the gallbladder towards the right falciform ligament, exposing the cystohepatic triangle, allowing for the safe clipping and division of the cystic duct and artery with absorbable clips before gallbladder removal (Fig. 1E, F).

The surgery was completed without complications, with an operative time of 35 minutes and minimal blood loss (5 ml). Pathology revealed chronic cholecystitis with polyps, without malignancy. The patient recovered well and was discharged on postoperative day 2, with no symptoms reported at the 3-month follow-up.

Case 2: A 55-year-old male was admitted with a 6-month history of vague upper abdominal discomfort. Physical examination showed no jaundice, and the abdomen was soft with mild tenderness in the right upper quadrant. Murphy's sign was negative. His past medical history included chronic bronchitis, for which he was regularly followed by the pulmonology department. Routine laboratory tests were unremarkable. Ultrasound suggested gallbladder inflammation with possible adenomyomatosis. MRI with MRCP showed an enlarged gallbladder with a diverticulum and suspected stones or polyps at the fundus (Fig. 1G). The imaging report did not indicate any abnormalities in gallbladder position. Laparoscopic cholecystectomy was performed, and intraoperatively, the gallbladder was found to be positioned to the left of the falciform ligament, with the infundibulum crossing the hepatic hilum anteriorly (Fig. 1H). The surgical setup and patient positioning were identical to Case 1. Due to unclear cystohepatic triangle anatomy, a retrograde cholecystectomy was performed. The cystic duct spiraled anteriorly and merged with the common hepatic duct, and the cystic artery, originating from the right hepatic artery, was divided into two branches supplying the gallbladder. Both the cystic duct and artery were safely clipped and divided (Fig. 1I). The surgery was completed uneventfully, with an operative time of 50 minutes and 5 ml of blood loss. Pathology showed chronic cholecystitis with acute inflammation and adenomyomatosis, with no malignancy. The patient was discharged on postoperative day 2, and no symptoms were reported during the 3-month follow-up.

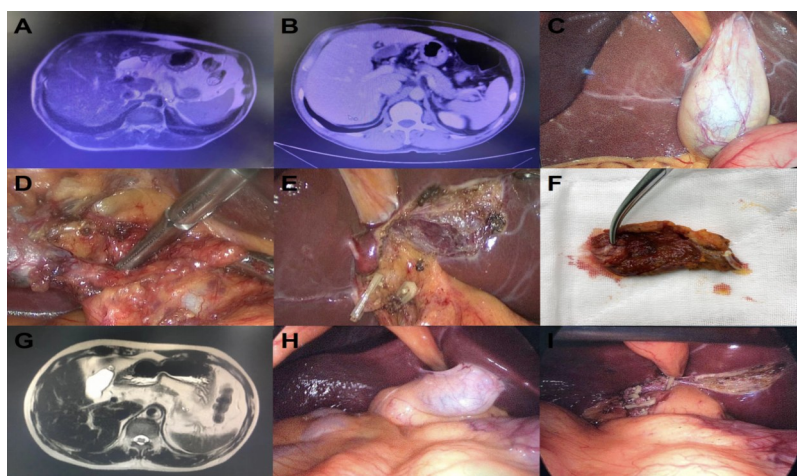


Fig.1 Imaging and Intraoperative Findings of Left-Sided Gallbladder in Laparoscopic Cholecystectomy. (A) MRI showing a possible left-sided gallbladder. (B) CT showing the gallbladder located to the left of the round ligament of the liver. (C) Laparoscopic view of the left-sided gallbladder. (D) Cystic duct and cystic artery of the left-sided gallbladder. (E) Liver surface exposed after gallbladder removal. (F) A polyp approximately 1.2 cm found inside the gallbladder. (G) Preoperative MRI findings. (H) Gallbladder infundibulum crossing anterior to the hepatic hilum. (I) Liver surface exposed after gallbladder removal.

3 Discussion

Left-sided gallbladder (LSG) is a rare congenital anatomical variation that presents significant challenges in clinical diagnosis and greatly increases the complexity and risk of surgery. Although its incidence is only 0.2% to 1.1% [2], LSG is typically discovered incidentally during surgery, as its position differs from that of a right-sided gallbladder, being located to the left of the falciform ligament, often between segments III and IV of the liver [6]. Despite the positional changes, the neural distribution remains unaffected, and patients generally present with symptoms similar to right-sided gallbladder diseases, such as right upper quadrant pain [7]. However, the complex anatomy of LSG, particularly variations in the cystic duct and artery, significantly increases surgical difficulty and the risk of bile duct injury [1, 2].

Two primary theories have been proposed regarding the pathogenesis of LSG: one suggests that the gallbladder bud migrates to the left, while the other posits that the gallbladder develops directly from the left hepatic lobe [8]. These theories help explain common anatomical variations in LSG patients, such as abnormal confluence of the cystic duct into the common bile duct or unusual courses of the cystic artery [1, 2]. Due to its rarity and anatomical variability, preoperative diagnosis of LSG is often challenging. Routine imaging modalities, including ultrasound, CT, and MRI, are generally limited in accurately identifying the gallbladder's position, especially when clinical symptoms are similar to right-sided gallbladder disease [9]. In most cases, LSG is discovered incidentally during surgery, emphasizing the need for thorough preoperative imaging review and heightened awareness of possible anatomical variations [1, 10]. In our cases, despite the absence of preoperative imaging abnormalities, careful dissection and evaluation during surgery confirmed the diagnosis of LSG. Once LSG is diagnosed intraoperatively, adjusting the surgical strategy is essential for a successful outcome. The traditional "4-port standard technique" (10-10-5-5) used in right-sided gallbladder surgeries may not provide adequate exposure in LSG cases, necessitating flexible adjustments. To better manage LSG, a "French-style trocar placement" is recommended, adjusting the trocar positions to optimize exposure of the left-sided gallbladder. This layout allows for improved visualization of the cystohepatic triangle and related structures, facilitating safer

dissection. Additionally, the patient's position should be adjusted to a head-up, right-tilted position to further enhance exposure. The assistant should retract the gallbladder toward the right falciform ligament, ensuring a clear view of the surgical field and improving safety.

LSG is further complicated by the possibility of the cystic duct and artery crossing the common bile duct in abnormal ways, increasing the risk of bile duct injury during surgery. As such, when dissecting the cystohepatic triangle, surgeons must exercise caution to avoid overdissecting the cystic duct and artery, preventing damage to nearby biliary structures. The literature reports that the risk of bile duct injury in LSG surgeries can be as high as 7% [12], underscoring the need for multiple preventive measures to minimize the incidence of complications. Following the Critical View of Safety (CVS) principle is crucial for reducing the risk of bile duct injury by ensuring clear identification of the cystic duct, cystic artery, and their relationships with the common bile duct [13].

In some complex cases, such as those involving a mirror-image gallbladder or complete situs inversus, the complexity of surgery can significantly increase. These anatomical variations require surgeons to adapt flexibly and have a deep understanding of the biliary anatomy [14]. Even if the gallbladder anatomy appears mirror-symmetrical, surgeons must remain vigilant for subtle anatomical differences [15]. Moreover, even when preoperative imaging suggests favorable surgical conditions, the placement of a cholecystostomy tube for bile drainage during surgery may be necessary in cases of severe cholecystitis to alleviate inflammation and ensure the safety of the procedure [16]. With technological advances, intraoperative cholangiography (IOC) has been widely applied to enhance the safety of cholecystectomy. IOC not only provides clear visualization of the biliary anatomy, helping to avoid bile duct injuries, but also facilitates the detection of common bile duct stones, reducing the risk of biliary complications [17, 18]. Especially in cases of complex anatomical variations like LSG, IOC offers more accurate intraoperative assessment and helps ensure surgical safety [17]. In addition to IOC, other key strategies for managing LSG include thorough preoperative imaging evaluation and the surgeon's ability to manage complex anatomy intraoperatively. While preoperative imaging may have limited sensitivity in diagnosing LSG, careful review of imaging studies combined with clinical findings can help identify potential anatomical variations. For complex anatomy, adjunct techniques such as ICG fluorescence imaging and intraoperative cholangiography can provide additional information to help surgeons avoid bile duct injuries [19, 20]. These technologies significantly improve surgical safety when dealing with LSG and provide a more comprehensive view for the surgeon during the procedure.

4 Conclusion

LSG is a rare and complex anatomical variation that is often difficult to diagnose preoperatively. However, by accurately identifying anatomical landmarks during surgery, adjusting trocar placement and patient positioning, and strictly adhering to CVS principles, surgeons can ensure the safety of the procedure. In more complex cases, intraoperative techniques such as cholangiography and ICG fluorescence imaging can further reduce the risk of bile duct injury. With a thorough understanding of anatomical variations, meticulous surgical technique, and flexibility in intraoperative management, surgeons can minimize the risk of intraoperative complications, improve the success rate of the procedure, and ensure optimal postoperative recovery for patients.

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