Section: Surgery

Case Series

RIGHT HEPATIC ARTERY CATERPILLAR HUMP WITH DUAL CYSTIC ARTERIES: A SURGICAL CHALLENGE IN A ROUTINE CHOLECYSTECTOMY

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ABSTRACT

Background: The tortuous right hepatic artery (Moynihan's or "caterpillar" hump) that courses within Calot's triangle is an uncommon but important anatomical variation that may closely approximate or be mistaken for the cystic artery, increasing the risk of vascular and biliary injury during cholecystectomy. Concomitant presence of dual (double) cystic arteries further complicates safe identification of structures. **Objective:** To describe the intraoperative findings, management strategies, and outcomes of a consecutive case series of patients in whom a caterpillar hump of the right hepatic artery was encountered together with two cystic arteries during attempted laparoscopic cholecystectomy and to highlight practical tips for safe dissection and prevention of vascular or biliary injury. **Methods:** We report a case series of five consecutive adult patients (age range and sex distribution summarized in main text) referred for elective or emergency cholecystectomy in whom the combined vascular variation (RHA caterpillar hump + dual cystic arteries) was identified intraoperatively. Standard laparoscopic technique aiming for the Critical View of Safety (CVS) was used; careful progressive dissection in the hepatocystic triangle, selective clipping of cystic artery branches adjacent to the gallbladder wall, and preservation of the RHA were emphasized. Operative details, intraoperative decision-making (conversion to open, additional vascular control, use of intraoperative cholangiography if performed), complications, and short-term outcomes were recorded. **Results:** In all five cases the RHA showed a prominent loop (caterpillar hump) entering the hepatocystic triangle; two distinct cystic arteries supplying anterior and posterior facets of the gallbladder arose either from the tortuous RHA or nearby branches. Meticulous dissection with identification of both cystic artery branches close to the gallbladder wall allowed safe clipping and division without RHA injury. There were no intraoperative major hemorrhages, no bile duct injuries, and no conversions to open surgery. Early postoperative recovery was uneventful in all patients; no hepatic ischemia or readmissions were recorded. **Conclusion:** The combination of a caterpillar hump of the RHA with dual cystic arteries is an important anatomic variant that poses a real risk during cholecystectomy. Awareness of the variant, strict adherence to the Critical View of Safety, cautious identification of arterial branches close to the gallbladder wall, and low threshold for obtaining help or converting to open if anatomy remains unclear are key to preventing vascular and biliary injuries. Reporting such series increases surgical awareness and prepares surgeons for safe intraoperative management.

INTRODUCTION

After emerging from the hepatic artery proper, the right hepatic artery crosses in front of the portal vein and then behind the common hepatic duct to enter the Calot's triangle, which is surrounded by the lower margin of the liver, the cystic duct, and the common hepatic duct.[1] It releases the cystic artery when it gets closer to the cystic duct, then twists upward to reach the right lobe of the liver behind (and between) the right hepatic and the cystic duct. The cystic artery, which generally emerges from the right hepatic within the triangle, travels through the triangle and eventually splits into two branches, one of which travels on the gall bladder's connected surface and the other on its peritoneal surface.[1-3]

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The "Culture for Safe Cholecystectomy (CSC)" is the foundation for one of the most crucial precautions taken during the cholecystectomy process. [4] Vascular damage has a death rate of less than 0.02% and an open surgery conversion rate of 0 to 1.9%. A convoluted right hepatic artery (RHA) that runs proximal and/or parallel to the cystic duct is a characteristic of the caterpillar or Moynihan's hump configuration, which predisposes to a tiny and/or short cystic artery (CA). In this case series, we reported seven patients who underwent elective laparoscopic cholecystectomy for symptomatic cholelithiasis, during which a rare anatomical variation of the right hepatic artery (RHA) forming a caterpillar hump—accompanied by dual cystic arteries—was identified intraoperatively.[3-5] This vascular anomaly posed significant challenges in achieving the critical view of safety (CVS) and avoiding iatrogenic injury. Careful dissection, modified surgical strategies, and intraoperative vigilance were employed to manage these cases safely. Each patient's intraoperative findings, surgical approach, and postoperative outcomes were documented to emphasize the clinical importance of recognizing this variant.[6] During laparoscopic cholecystectomy, iatrogenic biliary tract injuries had long received considerable attention; however, injuries to the right hepatic artery (RHA) were often overlooked and typically managed by simple clipping. This approach was largely based on the assumption that RHA injuries did not result in significant clinical consequences. Nevertheless, emerging studies had indicated that ligation of the RHA could lead to a range of ischemia-related complications, including liver abscesses, bile duct tumors, segmental liver atrophy, and anastomotic strictures.[7] These findings highlighted the importance of arterial blood flow in maintaining hepatic tissue viability, especially in the right lobe of the liver. Therefore, whenever feasible, restoring RHA blood flow through surgical reconstruction was considered a more appropriate strategy to minimize the risk of such complications and preserve liver function.[8]

INDIVIDUAL CASE PRESENTATIONS

Case 1: This A patient who underwent laparoscopic cholecystectomy for chronic cholecystitis was found to have a caterpillar hump of the RHA looping within Calot's triangle. Two cystic arteries—anterior and posterior to the cystic duct—were carefully clipped and divided after skeletonization. The procedure was completed without complications, and the postoperative course remained uneventful.

Case 2: During elective surgery for biliary colic, a tortuous RHA loop was identified crossing anterior to the common hepatic duct, with dual cystic arteries arising separately from the proximal and distal segments of the hump. The anterior cystic artery appeared short and fragile. Both arteries were meticulously isolated and clipped. The patient recovered without incident.

Case 3: In this case, the caterpillar hump passed posterior to the cystic duct and gave rise to two branches supplying the gallbladder. Dissection was performed from lateral to medial, and both vessels were securely clipped after clear identification of the bile duct. No intraoperative or postoperative complications were encountered.

Case 4: A patient with acute cholecystitis was found to have dense adhesions obscuring Calot's triangle. Dissection revealed a double-looped RHA with two cystic arteries emerging from each loop. Although the operation was technically demanding and prolonged, it was completed laparoscopically without conversion. The recovery proceeded without complications.

Case 5: This case involved a single-loop caterpillar hump of the RHA located posterior to the common bile duct, with two cystic arteries—one superficial and one deep. Due to the deep artery's vulnerable position, a fundus-first approach was adopted. Both vessels were identified and clipped successfully. The postoperative outcome was favorable.

Case 6: During surgery, a prominent anterior loop of the RHA was discovered, with two cystic arteries encasing the cystic duct. Since achieving the critical view of safety proved challenging, intraoperative cholangiography was utilized to aid in safe dissection. The procedure was completed without incident.

Case 7: In this routine cholecystectomy, an unanticipated caterpillar hump of the RHA was identified. Two closely spaced cystic arteries arose from different points of the arterial loop. Blunt dissection and bipolar cautery were used to minimize bleeding, and both arteries were managed successfully. The surgery and postoperative course were uneventful.

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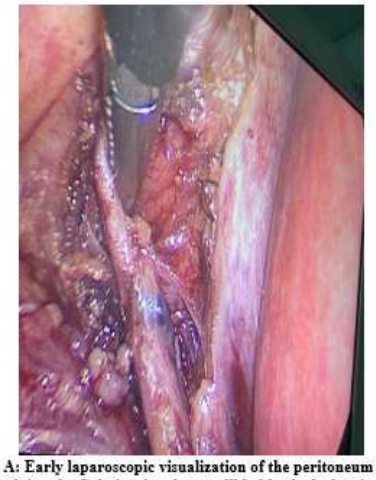
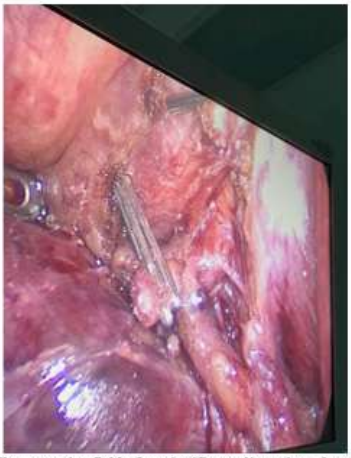
Highlights:

- Right hepatic artery (RHA) injuries during laparoscopic cholecystectomy are often underestimated.
- Simple clipping of the RHA may lead to serious ischemic complications.
- Restoring RHA blood flow can prevent liver abscess, atrophy, and bile duct damage.
- Microsurgical end-to-end anastomosis is a feasible method for RHA repair.
- Patients with RHA reconstruction showed favorable outcomes with no complications.

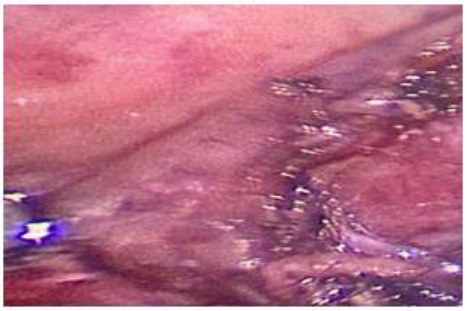


1 A: Early laparoscopic visualization of the peritoneum overlying the Calot's triangle or gallbladder bed, showing initial signs of inflammation and careful serosal dissection.

1B: Close-up view during the dissection of Calot's triangle, highlighting the careful isolation of the cystic duct and cystic artery. The relationship between the artery and the right hepatic artery/Moynihan's hump requires strict application of the Critical View of Safety (CVS).



1C: The operative field after significant dissection, showing the gallbladder bed and the exposure of the junction of the cystic duct with the common bile duct, confirming the route for cholecystectomy.



1D: Final stage of cystic duct and cystic artery management, showing clips being applied to secure both the duct and the artery prior to division. The potential for dual or short cystic arteries must be considered in this region.

DISCUSSION

A rare but deadly aberration, the tortuous right hepatic artery, also known as Moynihan's hump or caterpillar hump, has an incidence ranging from 1.9% to 12.9%.[9] The right hepatic frequently forms a distinctive caterpillar-like loop, with convexity pointing upward, downward, to the right, or to the left, both inside and outside of the Calot's triangle . The common hepatic duct can be reached by the tortuous artery either dorsally or ventrally, albeit the former is more typical. There are two loops on the hump, however the double loop is most typical.[10] Cystic arteries in double-looped hump can originate from the proximal or distal loop, with the latter being the more common. The distal loop's cystic artery is very short because of the loop's close proximity to the gall bladder, but the proximal loop's cystic artery is long and crosses over the tortuous right hepatic artery to reach the gall bladder. Uncontrolled cystic artery bleeding is a dangerous issue that can cause intraoperative harm to the biliary tract and important vessels.[11] The most frequent reasons for converting laparoscopic cholecystectomy to open

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cholecystectomy are typically the ensuing hemorrhage and bile leakage, and the mortality rate from blood vessel damage is 0.02%.[12]

A too-close closure of such a cystic artery would put the common bile duct at risk. The cystic artery from the gastroduodenal artery may be involved in duodenal ulcer perforations on the posterior wall. The main trunk or its branches may be affected in an anterior perforation where the gall bladder mass is located on the duodenum's wall. The location of this mutation should be considered during pancreatic transplantation or procedures involving the head of the pancreas and the terminal portion of the hepatopancreatic duct system.[13]

Identification of such variations has immense importance in radiological practice and helps the radiologists who perform intraoperative cystic angiogram during hepatobiliary surgeries For interventional radiologists performing arterial embolization and chemoperfusion of incurable liver tumors, artery identification and selection are crucial. Following hepatic artery embolization for incurable liver tumors, non-selective embolization may result in gallbladder infarction.[12,13]

Injuries to the right hepatic artery (RHA) during laparoscopic cholecystectomy had often been under-recognized compared to biliary tract injuries, yet they posed significant risks for postoperative complications when not properly managed. Traditionally, these injuries were treated with simple ligation or clipping, based on the assumption that collateral circulation would provide sufficient compensation.[11,12] However, clinical observations and studies had demonstrated that RHA ligation could lead to ischemic consequences such as liver abscesses, bile duct ischemia, hepatic atrophy, and anastomotic strictures. These outcomes highlighted the essential role of arterial blood supply in maintaining right hepatic lobe perfusion. In cases where reconstruction was technically feasible, intraoperative identification and end-to-end anastomosis of the RHA proved to be effective in restoring vascular continuity and preventing ischemic complications. The use of microsurgical techniques yielded favorable postoperative results and preserved liver function, emphasizing the importance of meticulous dissection and awareness of vascular anatomy during laparoscopic procedures.[14]

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