

# When a simple surgery become a disaster: Right hepatic artery injury during laparoscopic cholecystectomy

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## SUMMARY

Laparoscopic cholecystectomy (LC) is a standard surgical procedure for gallbladder removal, but complications such as vascular injuries can occur, transforming what should be a simple procedure into a potential disaster. This case report describes a 60-year-old woman with cholelithiasis who underwent LC under direct supervision of a digestive surgeon. During the procedure, while dissecting the fatty tissue between the gallbladder and duodenum, due to excessive fat and unclear structures, the surgeon inadvertently partially transected the right hepatic artery (RHA), mistaking it for the cystic artery due to an anatomical variation known as Moynihan's hump. The injury caused ischemia in the right lobe of the liver. Immediate laparoscopic repair of the RHA was performed using Prolene 7-0 sutures, with successful restoration of blood flow and recovery of liver color. Postoperatively, the patient's liver function normalized within a few days, and she was discharged on day six without complications. Follow-up imaging confirmed smooth blood flow in the RHA and no signs of liver damage. This case highlights the importance of recognizing vascular anomalies like Moynihan's hump during LC to prevent complications. It also demonstrates that laparoscopic repair of RHA injuries is feasible with skilled techniques, offering a minimally invasive solution for such complications.

## INTRODUCTION

Laparoscopic cholecystectomy (LC) is a common surgical procedure but major surgery, possible risks, and some complications may accompany it.<sup>1</sup> Therefore mandatory for the surgeon to be familiar with all techniques, including vascular variations in the extrahepatic biliary structure. A possible concern is that intraoperative bleeding due to vascular injury is usually seen with individual bile duct injuries, but can also occur as an isolated vascular injury. Such injuries can occur due to improper surgery as well as variations in blood vessels such as Moynihan's Hump.<sup>2,3</sup> The Moynihan's hump or caterpillar hump arrangement is characterized by a convoluted right hepatic artery (RHA). Its running proximal and/or parallel to the cystic duct and inclines to a little brief cystic artery (CA).<sup>4</sup>

Laparoscopic cholecystectomy, despite being the gold standard for gallbladder removal, is associated with a complication rate of 1.6%-5.3%, with biliary and vascular

injuries being the most significant. Recent studies indicate that biliary injuries are more common with laparoscopic cholecystectomy than with open cholecystectomy, occurring in 0.3%-0.5% of laparoscopic procedures. Risk factors for these complications include severe gallbladder inflammation, gallbladder fossa adhesions, chronic cholecystitis, and variant biliary anatomy, which may obscure the critical view of safety. Anatomical variations such as Calot triangle adhesions and gallbladder wall thickening greater than 5 mm have been identified as independent risk factors for complications after laparoscopic cholecystectomy.<sup>11</sup>

Vascular injuries during laparoscopic cholecystectomy, particularly to the right hepatic artery (RHA), occur in 12%-61% of cases with bile duct injuries, representing a potentially life-threatening complication. A multicenter study reported that 80.4% of vascular and biliary injuries occurred in non-specialized centers, with only 27.9% of patients undergoing vascular repair as first treatment. The need for vascular reconstruction has been associated with higher mortality rates, emphasizing the importance of early recognition and appropriate management. Laparoscopic repair of vascular injuries has emerged as a viable option, with studies demonstrating that reconstruction of the RHA can prevent complications associated with right hepatic ischemia, such as liver abscess, bile tumor, and liver atrophy. Successful early arterial reconstruction (within 4 days) has been shown to allow recovery from hepatic ischemia without evidence of hepatic atrophy or necrosis during follow-up, highlighting the importance of prompt intervention and specialized care.<sup>8,12</sup>

## CASE PRESENTATION

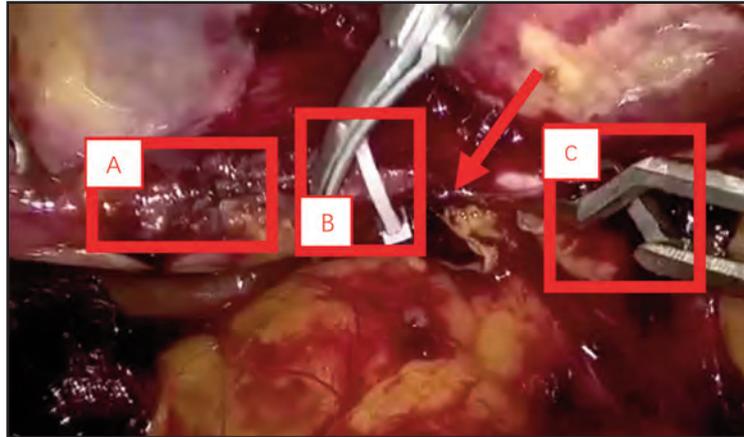
A 60-year-old woman came with complaints of recurrent pain in the right upper quadrant of the abdomen. The results of the preoperative ultrasound examination showed the presence of stones in the cystic sack so the patient was diagnosed with cholelithiasis. No contraindications to surgery were found in the routine preoperative examination. Subsequently, laparoscopic cholecystectomy was performed on the patient under direct supervision of a digestive surgeon, as part of a training program for laparoscopic cholecystectomy procedures.

The anatomic relationship between the cystic duct and the

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**Fig. 1:** The process of RHA anastomosis with the 7-0 Prolene suture (shown in the red arrow). In the figure, box A indicates the gallbladder, box B denotes the placement of a Hem-o-lok clip, and box C identifies the bulldog clamp.



**Fig. 2:** The RHA end to end anastomosis is completed (shown in the red arrow)

common bile duct is unclear in this patient. During dissection of the fatty tissue between the gallbladder and duodenum, due to excessive fat and unclear structures, what was thought to be the cystic artery was actually the right hepatic artery (RHA) in Calot's triangle which was partially transected, mistaken for a cystic artery, moreover known as Moynihan's configuration. The patient had a history of hypertension, which raised suspicion of high pressure, though pressure measurements were not performed during the procedure. The operator sees an RHA injury when there is still an ischemic line appears in the right lobe of the liver, similar to what typically occurs after portal vein branch ligation. Therefore, laparoscopic RHA repair was performed immediately by supervising surgeon. Laparoscopic RHA repair started with the addition of 5 mm Trocar ports in the right upper and left upper quadrants. Then each end of the RHA is clamped with Bulldog and made a framework. The RHA was partially ruptured, then repaired by instrumentation prolene 7.0 suturing (Fig. 1 and 2). After opening the clamp on the RHA, the color of the right lobe recovered or was bright red. Cholecystectomy is continued, the visible cystic duct is

clamped with a hemline as close as possible to the direction of the bladder. The proximal cystic duct is clamped with two metal clips and excised. The video scope is removed from the umbilical port and transferred to the epigastric port. Finally, the gallbladder was removed by pulling with forceps from the umbilical port, and the LC procedure was completed.

After performing repairing on RHA for 35 minutes on this patient, the color of the right lobe of the liver which was pale due to ischemia finally recovered to bright red. After surgery, the patient's serum transaminase level was slightly elevated but did not exceed three times the normal value, indicating mild hepatocellular injury without significant liver damage. Patients received symptomatic liver protective treatment with Stronger Neo-Minophagen C (SNMC) injections for 3 days. The patient was evaluated for 5 days without performing a follow-up CT scan for evaluation. The patient's liver function returns normally, and the patient can be discharged from the hospital on the fifth or sixth day postoperatively. Ultrasonography showed smooth blood flow in the RHA portal and showed no liver abscess or liver atrophy.

## DISCUSSION

The vascular injury that occurs during laparoscopic cholecystectomy most commonly affects RHA. Despite excellent visualization of the gall bladder and surrounding structures during laparoscopy, sudden anatomical variations can be a cause of concern for surgeons. Since the routine use of laparoscopic technique, there has been an increase in the incidence of injuries to the structures adjacent to the gall bladder, commonly the common bile duct, cystic duct and vessels. The most common variations encountered in this region include Moynihan's hump. The convoluted course of the right hepatic artery, also known as Moynihan's hump or caterpillar hump, is an uncommon but critical irregularity that needs to be recognized to anticipate intraoperative vascular and biliary injuries during surgical procedures involving the liver and biliary organs.<sup>5</sup> According to Sangameswaran et al., the frequency of patients with a caterpillar hump or Moynihan's hump of the right hepatic artery is reported in the literature to range between 1% and 12.9%. The convoluted artery may pass dorsal or ventral to the common hepatic duct, with the dorsal course being more common. In both cases in this study, the convoluted right hepatic artery passed dorsal to the common hepatic duct. The hump may have a single or twofold loop, a double loop could be a commoner. Based on Sangameswaran et al's findings, one specimen exhibited a single loop formation while another specimen demonstrated a double loop configuration. The loop may be located outside or inside Calot's triangle. As reported in Sangameswaran's study, the single loop was found completely within Calot's triangle, while in the double loop case, the proximal loop lay outside Calot's triangle and the distal loop was located inside it. In a twofold loop bump, the cystic artery can emerge either from the proximal or distal loop, beginning from the last mentioned is more visit. In the present study, the cystic artery from double looped right hepatic arose from the distal loop. The cystic artery route emerging from the proximal loop is long and crosses over the convoluted right hepatic artery to reach the gall bladder whereas that emerging from a distal loop is exceptionally brief owing to the loop's nearness to the irritate bladder. The cystic course emerging from a single loop right hepatic course was long and the one emerging from the distal loop of twofold loop right hepatic was brief.<sup>6</sup>

According to the literature, right hepatic artery injury (RHA) accounts for 6.1-67% of the total incidence of biliary duct injury (BDI). Causes of RHA injury include anatomic abnormalities, pathological changes, artificial factors, technology, or even human error. If the surgeon is unfamiliar with or pays little attention to variations of the RHA, in cases of acute and chronic cholecystitis with unclear Calot's triangle anatomy, the RHA may be inadvertently spliced, mistaking it for a cystic artery.<sup>7</sup> In the case that describes the mechanism of transection of RHA in this patient, it occurs by mistaking RHA for a cystic artery. This excessive arterial pulsation was noted at the distal end of the RHA after the disconnection of electrocoagulation and makes the right lobe of the liver appear ischemic lines due to reduced blood supply to the right lobe of the liver.<sup>8</sup> The cystic artery passes through Calot's triangle and originates from a branch of the right hepatic artery (RHA). The bifurcation of the cystic artery divides into deep and superficial branches to the neck of the

gallbladder. At the time of the LC procedure, the cystic artery tends to be hidden behind the gallbladder and is located slightly deeper and opposite the cystic duct. In one study, this type of variation was documented (73.3%) in 440 of 600 patients. Complicated deviations between the cystic arteries can increase the chance of injury during the LC procedure.<sup>9</sup> Therefore in this case the researcher attempted to explore several variations of cystic arteries, their complications, and management.

In the management of RHA injuries that occur during LC procedures, there is still much uncertainty and controversy in the existing studies. Several studies have shown that RHA ligase can cause pathological changes such as arterial ischemia, liver abscess, bile tumors, liver atrophy to anastomotic stenosis.<sup>10</sup> Li reported in his study that 3 out of 10 patients with RHA and BDI injuries had liver atrophy, liver abscess, and other manifestations. Other studies have suggested that the liver is double vascularized so that after RHA injury, a portion of the right lobe can receive collateral circulation from the uninjured left hepatic artery (LHA), to supply blood through the portal area and the perihepatic ligament. Therefore complex RHA repair is considered unnecessary. Yi Yu and Strasberg SM reported that only 10% of patients with RHA injury would develop a right hepatic infarct, and considered RHA too complex to repair because the effect was insignificant. Wu Bao's study suggested that the occurrence of complications after RHA injury may correlate with the location of the vascular injury or with bile duct injury as well. As in this case, vascular injury of the complicated junction site will impair the left-to-right blood supply, and the vascular plexus on the surface of the bile duct can lead to right hepatic ischemia and necrosis, or bile duct failure. This results in the appearance of a clear line of right hepatic ischemia in patients after RHA injury. Therefore, the blood flow of the injured RHA should be restored as soon as possible. To avoid the possibility of long-term complications, such as right hepatic ischemia.<sup>10</sup>

Based on the existing literature a few patients undergo reconstruction after switching to open surgery. Only one patient with an injury to the lateral wall of the RHA underwent laparoscopic-assisted reconstruction. The authors consider that laparoscopic magnification can display RHA and help assess surrounding tissue inflammation more clearly when compared to open surgery.<sup>10</sup> If the patient meets the indications for an end-to-end RHA anastomosis, RHA reconstruction can be completed with a laparoscope. Indeed, this requires a skilled vascular suture technique and a good work team. In this study, patients underwent repair of RHA transected with Prolene 7-0 sutures, the time to the separation of surrounding vessels and anastomoses was approximately 30 minutes. After the RHA blood flow is opened, the right half of the liver quickly recovers to a bright red, and the effect is fast and significant.

## CONCLUSION

Laparoscopic RHA repair is feasible. Indeed, the number of cases in the study was small and the duration of follow-up was short. Therefore, meaningful long-term conclusions cannot

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