A 56-Year-Old Woman with Acute Cholecystitis and a Moynihan’s Hump, or Caterpillar Configuration, of the Right Hepatic Artery Identified During Laparoscopic Cholecystectomy

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Patient: Female, 56-year-old
Final Diagnosis: Cholecystitis and caterpillar configuration
Symptoms: Abdominal pain in the right upper quadrant • nausea • vomiting and abnormal warm and cold sensation
Medication: —
Clinical Procedure: —
Specialty: Surgery

Objective: Rare disease
Background: When performing a cholecystectomy, several variations can be encountered by the surgeon. The “Moynihan’s hump” or “caterpillar configuration” of the right hepatic artery are the terms used to describe a tortuous right hepatic artery running proximal or parallel to the cystic duct, resulting in a small or short cystic artery and occupying most of Calot’s triangle. This report is of a 56-year-old woman with acute cholecystitis and a Moynihan’s hump or caterpillar configuration identified at laparoscopic cholecystectomy.

Case Report: A 56-year-old woman presented herself to the Emergency Department with abdominal pain in the right upper quadrant for a week, associated with nausea, vomiting, and abnormal warm and cold sensation. Acute cholecystitis was diagnosed with ultrasound, and a laparoscopic cholecystectomy using a 4-port technique was performed. During the dissection of Calot’s triangle, a large pulsatile vessel forming a loop was found, which turned out to be the right hepatic artery. The anatomic variation that was observed during the procedure is called Moynihan’s hump or caterpillar configuration of the right hepatic artery. The surgery was uneventful, and the patient was discharged the next day.

Conclusions: The Moynihan’s hump or caterpillar configuration of the right hepatic artery is a rare anomaly, with an incidence reported to be between 1.3% and 13.3%. This report has shown that although a Moynihan’s hump or caterpillar configuration of the right hepatic artery is rare, the surgeon should be aware of this anatomic anomaly when performing gallbladder surgery to prevent arterial damage and operative complications.

Keywords: Laparoscopic Cholecystectomy • Hepatic Artery Abnormalities • Caterpillar Hump • Moynihan’s Hump • Calot’s Triangle Variant

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Background

Gallbladder stones are very common and affect 10% to 15% of the population in Europe [1,2]. When they become symptomatic or when an acute cholecystitis is diagnosed, a laparoscopic cholecystectomy is proposed to treat the disease, except for patients who have an anesthesiologic contraindication or who are in septic shock [3,4]. In these cases, conservative management with antibiotics is proposed [4]. For patients who are in septic shock or for cases of failed conservative management after 24 h to 48 h, gallbladder drainage can be performed, allowing the decrease of local inflammation by removing the infected material in the gallbladder [4].

Even if laparoscopic cholecystectomy is less invasive, decreases postoperative pain and hospital stay, and provides a better cosmetic results, the risk of biliary tract lesions and hemorrhage is higher than that of open surgery [5-7]. In fact, the rate of bile leakage after open cholecystectomy varies between 0.1% to 0.5%, compared with 3% with the laparoscopic method [6,7]. To limit complications, knowledge of the gallbladder's anatomy and its possible variations is therefore mandatory for the surgeon.

Classically, the right hepatic artery (RHA) arises from the proper hepatic artery and runs upward to the right lobe of the liver, crossing the common hepatic duct [8,9]. It delivers the blood supply for the right lobe of the liver and a part of the common bile duct [8,9]. The cystic artery, which provides the blood supply for the gallbladder, originates from the RHA and enters a space called Calot's triangle or the hepatocystic triangle [10-12]. The hepatocystic triangle is formed by the common hepatic duct, the cystic duct and gallbladder neck, and the inferior portion of the liver, and Calot's triangle is formed by the common hepatic duct, cystic duct, and cystic artery [13-15]. To note, some authors also refer the hepatocystic triangle as the modern definition of Calot's triangle [16,17]. Both represent key landmarks for the surgeon performing cholecystectomy, especially Calot's triangle; an incomplete dissection and misidentification of the cystic artery and cystic duct can lead to accidental vascular or ductal injuries [10,18]. Thus, in 1995, Strasberg et al introduced the concept of the "critical view of safety" to ensure the identification of the 2 cystic structures before removing the gallbladder [18,19].

Several anatomical variations of the RHA have been described, but one of the most dangerous is the Moynihan's hump or caterpillar configuration of the RHA [10-12]. In this case, the RHA forms a loop which can point upward or downward and runs close to the cystic duct, with a short cystic artery, which can arise from the distal or the proximal loop [20,21]. It occupies most of Calot's triangle, and damage to this vessel can lead to significant mortality and morbidity [10-12]. We present a case of a 56-year-old woman with acute cholecystitis and a Moynihan's hump or caterpillar configuration of the RHA, which was identified during laparoscopic cholecystectomy.

Case Report

A 56-year-old woman known to have gallstones with episodes of biliary colic in the past presented herself to the Emergency Department with abdominal pain in the right upper quadrant for a week, which was associated with nausea, vomiting, and abnormal warm and cold sensation. The pain radiated to the right shoulder and the back and was exacerbated by food intake. She had no other bowel or genitourinary symptoms.

The physical examination revealed pain in the right upper quadrant, with a positive Murphy sign. Blood results showed slight inflammation, with a C-reactive protein level of 23 mg/L, without leucocytosis or elevated liver tests. Acute cholecystitis was diagnosed by ultrasound. A laparoscopic cholecystectomy using a 4-port technique was therefore performed the same day.

Laparoscopic exploration showed a necrotic gallbladder with few epiploic adhesions to the body. During the dissection of Calot's triangle using a monopolar hook, a large pulsatile vessel forming a loop was found, which turned out to be the RHA. Further dissection revealed a very short cystic artery arising from the RHA and a short cystic duct (Figures 1, 2). Once the critical view of safety was obtained in the anterior and posterior aspect, the cystic artery was clipped and sectioned close to the gallbladder to avoid unwanted damage to the RHA. The cystic duct was also sectioned after performing a cholangiography, which was normal (Figure 3). The gallbladder was then removed from the liver bed (Figure 4). The total operative time was 2 h and 32 min, and the estimated blood loss was minor. Pathology results showed a gangrenous acute calculous cholecystitis. The anatomic variation, which was observed during this procedure, is called Moynihan's hump or caterpillar configuration of the RHA. The postoperative evaluation of the patient showed no complications. She was discharged the day after the surgery.

Discussion

The Moynihan's hump or caterpillar configuration of the RHA is an anatomic variation that has a high clinical importance. Our objective in this case report is to provide an overview of the subject to give every surgeon who is going to perform a cholecystectomy the opportunity to be aware of this variation and avoid serious complications.

Laparoscopic cholecystectomy is one of the most performed surgical procedures worldwide and is considered the criterion...
standard to treat gallstone disease [22,23]. However, not all cholecystectomies are straightforward procedures, especially in cases of anatomic variations and severe inflammation of the gallbladder. Anatomic variations around Calot’s triangle can be found in 20% to 50% of patients, but are not always recognized before surgery [5,24]. In fact, most of the patients with a suspicion of gallbladder disease will have an abdominal ultrasound as first intention imaging, as recommended by the American College of Radiology [25]. However, unlike the computed tomography scan or magnetic resonance imaging, ultrasound cannot provide a precise anatomy of the biliary and vascular system [26], which can lead to challenging procedures, especially in cases of great inflammation of the gallbladder associated with anatomical variations. Moreover, to stratify the severity of the cholecystitis and predict the level of difficulty of the operation, in 2017, Madni et al developed a grading scale using intraoperative images of the gallbladder, called the Parkland grading scale [27]. The scale includes

**Figure 1.** Intraoperative view showing the anatomical variation of the right hepatic artery (RHA). The short cystic artery (CA) was clipped with hem-o-lok clips before being sectioned. Common biliary duct (CBD), cystic duct (CD), gallbladder (GB), and hepatic hilum (HH).

**Figure 2.** Schematic intraoperative picture of right hepatic artery (RHA), cystic artery (CA), common biliary duct (CBD), common hepatic duct (CHD), cystic duct (CD), gallbladder (GB), Calot’s Triangle (CT), and hepatic hilum (HH).

**Figure 3.** Intraoperative cholangiography. Common biliary duct (CBD), common hepatic duct (CHD), cystic duct (CD), right hepatic duct (RHD), and left hepatic duct (LHD).

**Figure 4.** Intraoperative view after cholecystectomy showing right hepatic artery (RHA), cystic artery (CA), common biliary duct (CBD), cystic duct stump (CDS), liver bed (LB), and hepatic hilum (HH).
5 grades: a normal gallbladder is seen in grade 1, minor adhesions to the lower part of the gallbladder otherwise normal are found in grade 2, adhesions to the body of the gallbladder, a distended gallbladder or the presence of hyperaemia or pericholecystic fluid are found in grade 3, adhesions to most of the gallbladder, the presence of a Mirizzi syndrome, an intrahepatic gallbladder or grade 1 to 3 associated with an abnormal liver anatomy are seen in grade 4, and finally the presence of a necrotic or perforated gallbladder or adhesions covering the gallbladder are seen in grade 5 [27].

During our surgery, we found grade 5 cholecystitis, which made the laparoscopic cholecystectomy even more complex in the presence of the caterpillar hump.

A Moynihan’s hump or caterpillar configuration of the RHA is a rare anomaly, with an incidence reported to be between 1.3% and 13.3% [5,12,28-30]. The tortuous RHA can form a single or double loop, and pass posteriorly or anteriorly to the common hepatic duct, with the posterior presentation being the most common [5,12,30]. When a double loop is present, the cystic artery can arise from the proximal part and cross over the RHA before reaching the gallbladder, or it can originate from the distal part and be extremely short [5,12,30,31]. The latter is more common [12,30,31]. In the present case report, the RHA was a double loop, with a short cystic artery arising from the distal loop.

The etiology of this anomaly remains unknown, but different authors have made suppositions. Taylor et al hypothesized that the architecture of the Moynihan’s hump or caterpillar configuration of the RHA could be the consequence of cirrhosis, which leads to a distortion of the intrahepatic branches of the hepatic artery [32]. However, neither our patient nor the ones presented in various case reports were affected by cirrhosis [5,33,34]. Miyaki et al suggested that the RHA variation could be the result of a partial or complete persistence of the foetal arterial blood supply [35].

An injury to the RHA during laparoscopic cholecystectomy can lead to significant bleeding and conversion to an open procedure [36-39]. If the RHA is ligated, cauterized, or sectioned, it can cause right liver ischemia, atrophy, necrosis, or abscess formation, as reported in several articles [36-39]. It can also result in bile duct stenosis due to ischemic injury (the RHA supplying the common bile duct in blood, as mentioned in the introduction), and therefore can result in cholangitis and even cirrhosis [40,41]. Some authors noticed that right hepatic lobectomy was necessary after a lesion of the RHA [42-44]. Bacha et al even described a case in which liver transplantation was required due to the ligation of the RHA, which ultimately resulted in right liver necrosis, septic shock, and multiple-organ failure [45]. However, some authors also suggested that a lesion to the RHA could be asymptomatic because of the presence of collateral circulation from the left hepatic lobe [19,38,46,47].

For instance, in their review, Strasberg et al noted that an RHA injury results in right liver infarction in only 10% of patients, and that the repair of the vessel is not always possible and beneficial [19]. In an experimental study on rats, Soares et al demonstrated that the ligation of an hepatic artery in cases of a normal liver reduces the volume of bile ducts, but has no consequences on liver function, with levels of bilirubin and liver enzymes remaining unchanged [48]. Nevertheless, if the hepatic artery ligation occurs in the presence of extrahepatic cholestasis, hepatic necrosis is more likely to happen [48]. Therefore, if an RHA injury is diagnosed during a laparoscopic cholecystectomy, some authors suggest that a direct reconstruction with an end-end anastomosis can be conducted with no complications [38,49,50]. However, other authors advise against a repair, considering that a patient with a normal liver can be asymptomatic [19,48,51].

Thus, to ensure a safe surgery and avoid potentially serious complications, the surgeon should always strive for the critical view of safety before clipping the cystic duct and artery, as introduced by Strasberg in 1995 [19]. Three conditions are necessary to obtain the critical view of safety: the hepatocystic triangle should be identified and cleared of all fibrous and fatty tissue, the infundibulum of the gallbladder should be dissected off the liver bed, and only 2 structures should be entering the gallbladder, namely the cystic artery and the cystic duct [18,52].

Failure to correctly identify all the structures of Calot’s triangle can lead to bile or blood leakage, which is the most common cause of conversion to open cholecystectomy [31,33]. Reported mortality due to blood vessel injury is 0.02% [24,31].

The present paper represents a case report with a high clinical significance, as the recognition of anatomic variants of Calot’s triangle, such as the Moynihan’s hump or caterpillar configuration of the RHA, are important to avoid complications, including bleeding and bile duct injury. Previous articles also reported the anatomic variation [29,53], but our case report has the advantage of not only providing good quality perioperative images of the Moynihan’s hump or caterpillar configuration of the RHA before and after the removal of the gallbladder, but also of guiding the reader and the surgeon through the recognition of this anatomic variation and the strategies or procedures to conduct during laparoscopic cholecystectomy if an injury to the RHA is presented.

Conclusions

The Moynihan’s hump or caterpillar configuration of the RHA is an anatomic variation, which can be encountered during laparoscopic cholecystectomy, one of the most commonly
References:

7. Renz BW, Blisch F, Angel T. Bile duct injury after cholecystectomy: Surgical damage and operative complications. Before clipping the cystic duct, especially in cases of grade 5 Parkland cholecystitis, in which the structures are difficult to dissect and isolate.

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