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Original Article

An anatomical study of Moynihan's hump of right hepatic artery and its surgical importance

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ABSTRACT

Introduction: Tortuous course of right hepatic artery, also known as Moynihan's hump or caterpillar hump is a rare but important anomaly to be recognized to prevent intraoperative vascular and biliary injuries during surgical procedures involving the liver and biliary apparatus. The present study is intended to know the incidence and anatomy of the Moynihan's hump of right hepatic artery emphasizing its relevance in current surgical practice.

Materials and methods: The present study was conducted on 40 adult cadavers of both sexes allotted to undergraduate students at Bangalore Medical College and Research Institute, Bangalore and Shimoga Institute of Medical Sciences, Shimoga. The right hepatic artery was exposed by dissection method and was observed for the presence of caterpillar hump.

Results: Out of 40 cases, caterpillar hump of right hepatic artery was found in two cases (5%). One case showed the presence of single loop facing downwards and the other showed double loops, proximal loop facing upwards and the distal loop toward the right. The cystic artery arising from the double looped right hepatic artery was short.

Discussion: Knowledge of anatomy and recognition of vascular variations are essential prerequisites for safe and uneventful laparoscopic cholecystectomy.

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1. Introduction

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, accessory cystic artery, double cystic duct and long cystic duct.[1] Introduction of laparoscopic cholecystectomy makes it mandatory to have a thorough knowledge of normal anatomy and variations in this region to reduce the likelihood of uncontrolled intraoperative bleeding, iatrogenic extrahepatic biliary injury and conversion to open cholecystectomy.[2] Reported incidence of conversion to open surgery because of vascular injury is 0–1.9% and mortality is 0.02%.[3]

The right hepatic artery after its origin from hepatic artery proper crosses anterior to the portal vein and then passes behind the common hepatic duct to enter the Calot's triangle (bounded by cystic duct, common hepatic duct and lower edge of the liver). As it approaches the cystic duct, it gives off the cystic artery and then turns upwards, behind (and between) the right hepatic and the cystic duct to the right lobe of the liver. The cystic artery normally arising from the right hepatic within the triangle, passes in the triangle toward the neck of gall bladder where it typically divides into two branches one of which runs on the attached surface of the gall bladder and the other on its peritoneal surface.[4]

Variations in the origin and branching pattern of right hepatic artery have been reported. But tortuous right hepatic artery, running with upward and downward course producing hump is rarely described dangerous anomaly. This sinuosity of the right hepatic artery is called caterpillar hump or Moynihan's hump.[5] Both inside and outside the Calot's triangle, the right hepatic often makes a characteristic caterpillar like loop, convexity of which points downward, upward, to the right or to the left. In cholecystectomy, such sinuosities of the right hepatic are extremely vulnerable, for the cystic artery may arise from the distal or the proximal end of the loop, in the latter instance crossing

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it. The U shaped loop may be nearer to the cystic duct than the cystic artery itself and it has been observed to overlie the point of union of the cystic duct with the hepatic duct.[6] The right hepatic artery normally courses behind the bile duct and joins the right pedicle high up in the Calot's triangle. In caterpillar configuration, the right hepatic artery comes very close to the gall bladder and cystic duct in the form of hump resulting in short cystic artery.[7]

A sound knowledge of possible existence of such vascular variations is essential for surgeons to prevent iatrogenic injuries in this region. Minor variations in anatomy can result in major iatrogenic injury to the adjacent structures and thus lead to increase in mortality and morbidity of patients, increases the cost of treatment and hospital stay.[1] The present study is aimed to know the incidence and clinical importance of caterpillar hump of the right hepatic artery.

2. Materials and methods

The present study was conducted in 40 adult cadavers of both sexes allotted to undergraduate students at Bangalore Medical College and Research Institute, Bangalore and Shimoga Institute of Medical Sciences, Shimoga from 2008 to 2013. Abdomen was opened following the Cunningham's manual and liver was pulled superiorly to expose the lesser omentum. The hepatic artery and its branches were traced from origin to their termination at the porta hepatis. The right hepatic artery was observed for the presence of caterpillar hump and when present the tortuosity was studied with respect to the number of loops, relation to surrounding structures and branches arising from the hump.

3. Observations

Out of the 40 cadavers studied, caterpillar hump of right hepatic artery was found in 2 cases (5%).

In specimen no 6 (Fig. 1), the common hepatic artery trifurcated into right hepatic, left hepatic and gastroduodenal artery. The right hepatic gave middle hepatic artery and then passed behind the common hepatic duct into the Calot's triangle and formed a loop facing downwards. The cystic artery arose from the distal part of the loop.

In specimen no 36 (Fig. 2), the right hepatic artery arose from hepatic artery proper, and then formed a loop directed upwards as it crossed the portal vein. It then passed behind the common hepatic duct to enter the Calot's triangle where it formed another loop facing toward the right. A short cystic artery was given by the proximal part of the distal loop of the right hepatic artery which then entered the right lobe of liver. Here the caterpillar loop of right hepatic lies partly outside (proximal loop) and partly inside the Calot's triangle (distal loop). There was an additional long cystic artery from the superior pancreaticoduodenal branch of gastroduodenal artery given to the gall bladder in this case.

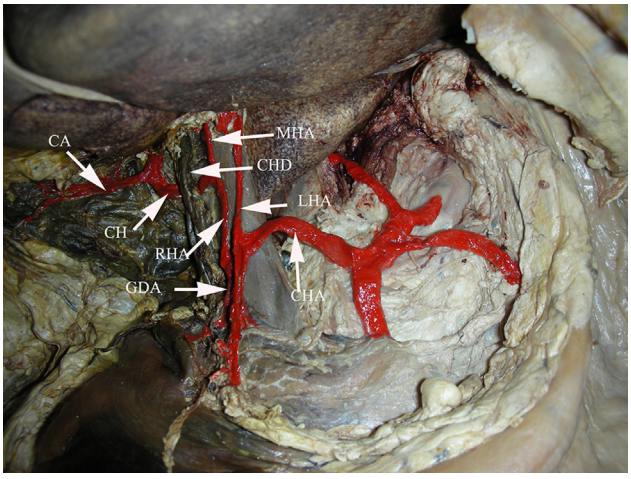

Fig. 1. Specimen no 6 showing single looped caterpillar hump of right hepatic artery in the Calot's triangle. (CHA – common hepatic artery, LHA – left hepatic artery, RHA – right hepatic artery, GDA – gastroduodenal artery, MHA – middle hepatic artery, CH – caterpillar hump, CA – cystic artery, CHD – common hepatic duct).

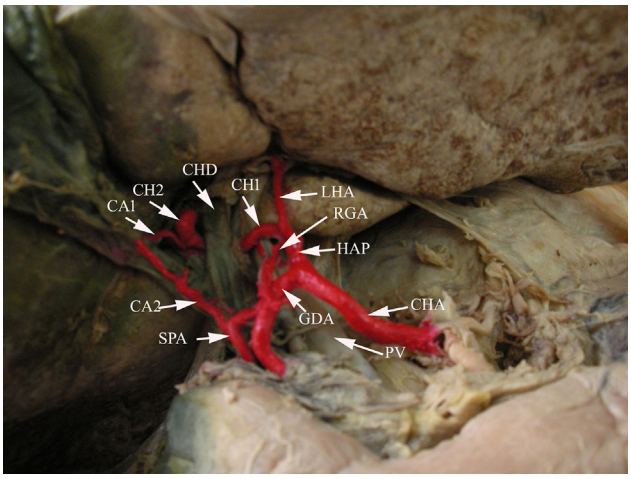

Fig. 2. Specimen no 36 showing double looped caterpillar hump of right hepatic artery. (CHA – common hepatic artery, HAP – hepatic artery proper, LHA – left hepatic artery, RGA – right gastric artery, CH1 – proximal loop of caterpillar hump of right hepatic artery, CH2 – distal loop of caterpillar hump of right hepatic artery, GDA – gastroduodenal artery, CA1 – cystic artery from right hepatic artery, CA2 – cystic artery from superior pancreaticoduodenal artery, SPA – superior pancreaticoduodenal artery, CHD – common hepatic duct, PV – portal vein).

4. Discussion

The incidence of caterpillar hump of right hepatic artery in previous studies conducted ranged between 1% and 12.9% (Table 1).[1,5,7–12] Its incidence in the present study was 5%, which is within this range.

The tortuous artery may pass dorsal or ventral to the common hepatic duct, but former is more common.[5,6,13] In present study, in both the cases the tortuous right hepatic artery passed dorsal to the common hepatic duct.

The hump may have single or double loop, double loop is commoner.[5,13] In present study, in one case single loop was seen and the other case showed the presence of double loops. The loops may be seen outside or within the Calot's triangle.[5,6] In present study, the case with single loop was restricted to the Calot's triangle and in the case with double loop, proximal loop was outside and distal loop was within the Calot's triangle.

In double looped hump, cystic artery can arise either from proximal or distal loop, origin from latter is more frequent.[5,13] In the present study, the cystic artery from double looped right

Table 1
Showing incidence of Moynihan's hump of right hepatic artery in various studies.

Study	Year	Moynihan's hump (%)
Johnston et al.[8]	1952	2.86%
Bergamaschi et al.[9]	2000	12.9%
Ayyaz et al.[10]	2001	1%
Hamza et al.[7]	2008	4%
Al-Sayigh[11]	2010	4%
Prithi et al.[12]	2010	1.6%
Jansirani et al.[5]	2012	5%
Dawani et al.[1]	2013	5.9%
Present study	2015	5%

hepatic arose from the distal loop. Cystic artery arising from the proximal loop is long and crosses over the tortuous right hepatic artery to reach gall bladder while that arising from distal loop is very short owing to loop's proximity to the gall bladder.[13] In the present study, the cystic artery arising from single looped right hepatic artery was long and the one arising from distal loop of double looped right hepatic was short.

4.1. Surgical significance

A bend in the course of the right hepatic artery throwing it into the caterpillar hump invites injury unless it is carefully dissected free.[12] This variant of right hepatic artery invariably leads to abnormalities of cystic artery formation which can result in its injury during surgical procedures namely cholecystectomy, liver transplantation, resection of tumors of pancreatic head, chemoembolization of pancreatic and liver tumors, etc.[13,14]

Since the cystic artery arising from the loop is typically short, it may get easily avulsed from the hepatic artery, if excessive traction is applied to the gall bladder producing brisk bleeding.[1,5,11,12] Uncontrolled arterial bleeding during laparoscopic cholecystectomy is a serious problem which predisposes to biliary injury. So accurate identification of cystic artery is important.[7,11]

In presence of short cystic artery arising from the distal loop, chances of avulsion of right hepatic artery is also high if excessive traction applied on the gall bladder or during hooking and ligation of the cystic artery. Sometimes tortuous right hepatic artery does not give a single cystic artery but supplies the gall bladder with several small twigs. The right hepatic artery is injured while securing them. Injury to right hepatic artery can be fatal in presence of impaired liver function.[5,11,13]

The tortuous right hepatic artery lies in close proximity to the gall bladder and cystic duct and so it may be mistaken to be cystic artery and inadvertently ligated during surgical procedures like cholecystectomy and liver transplantation.[5,7,11,13] So caterpillar hump should be suspected when an unusually large 'cystic artery' is seen through the laparoscope.[5,12] It must be emphasized that an artery resembling the cystic artery in its course and paralleling the cystic duct is not necessarily the cystic artery but may be right hepatic artery and the caliber of vessels to be divided is not a reliable index of whether it is cystic artery or right hepatic artery. Therefore it is essential to visualize right hepatic artery above and below the origin of cystic branch.[11]

Pseudoaneurysm of hepatic artery following injury to the vessel wall is a rare post-operative complication of laparoscopic cholecystectomy requires prompt attention because of high risk of rupture.[15] Some of the safety rules, if followed during cholecystectomy may help surgeons avoid complications with Moynihan's hump of right hepatic artery. The infundibulum should be freed first to widen the Calot's triangle. The cystic artery should be traced up to the gall bladder wall before ligation to prevent mistaken identity. The cystic duct and cystic artery should be ligated separately to avoid arterio-biliary fistula. Keeping dissection plane close to the gall bladder wall is very important. Bright illumination of operative field and perfect control of bleeding during surgery improves visibility, hence must be ensured. In case of bleeding, surgeon should never attempt blind clipping or coagulation and not hesitate to convert a laparoscopic cholecystectomy to open cholecystectomy.[5,13,15]

5. Conclusion

Thus it is very important for surgeons to appreciate this variant of right hepatic artery and take appropriate safety measures during surgery to avoid fatal intra and postoperative complications including ischemic necrosis of right lobe of the liver. This study emphasizes the necessity of every laparoscopic surgeon being well aware of vascular variations and anomalies to be accomplish safe and uneventful laparoscopic cholecystectomy.

Conflicts of interest

The author has none to declare.

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