A unique case of combined variations of the cystic artery and biliary tree complicating the management of acute cholecystitis

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SUMMARY

Anatomic variations of the biliary tree and/or the vascular supply of the gallbladder pose challenges in the surgical management of diseases and conditions of the liver-biliary tree and the pancreas. A patient with acute cholecystitis underwent imaging investigation preoperatively with computed tomography of the abdomen and magnetic resonance cholangiopancreatography, which revealed a unique combination of variations: the cystic artery originated from the superior mesenteric artery and the right posterior sectoral duct drained at the same point with cystic duct to the common hepatic duct. The patient underwent open cholecystectomy and her postoperative period was uneventful. The surgeon should be aware of these variations in order to avoid intra- or post-operative complications, and the radiologists should report these variations because they could have a significant clinical impact.

Key words: Cystic artery variations – Biliary tree variations – Right posterior duct variations – Surgery – Imaging

INTRODUCTION

Anatomic variations of the biliary tree and/or the vascular supply of the gallbladder pose challenges in the surgical management of diseases and conditions of the liver-biliary tree and the pancreas. The cystic artery typically arises from the right hepatic artery and courses within the cystohepatic triangle to the right common hepatic duct (Andall et al., 2016). It then travels superior to the cystic duct at the gallbladder neck, after which it bifurcates into a deep and a superficial branch to supply the gallbladder and the cystic duct (Andall et al., 2016). The cystic artery may also have origin from nearby arteries such as the left hepatic artery, the gastroduodenal artery, the proper hepatic artery, the celiac trunk, the bifurcation of the proper hepatic artery, the superior pancreaticoduodenal artery, and the superior mesentery artery (SMA) (Andall et al., 2016).

The most common drainage of the right liver lobe ducts is through the right posterior and the right anterior sectoral ducts, the confluence of which forms the right hepatic duct (RHD) (Cucchetti et al., 2011). In the literature, many anatomic variations regarding the anatomy of the bile duct tree have been described. The pattern of

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Submitted: October 10, 2022. **Accepted:** December 1, 2022
https://doi.org/10.52083/NFCW2491

the biliary tree in the right and left lobe has been classified into several types by some studies (Cucchetti et al., 2011; Chaib et al., 2014).

We present a unique case where a combination of cystic artery and biliary tree variations complicate the management of a patient with acute cholecystitis. The present case report adheres to the CARE checklist for reporting clinical cases.

CASE PRESENTATION

A 52 year-old female patient was admitted to the Department of General Surgery of our Hospital due to acute calculous cholecystitis. The diagnosis was set from her clinical presentation, the abnormal liver function tests, the elevated inflammatory markers and initial imaging with ultrasound examination of the liver and biliary tract. The patient was further investigated with computed tomography (CT) (Fig. 1) of the abdomen due to suspected complicated cholecystitis and with magnetic resonance cholangiopancreatography (MRCP) (Fig. 2) due to suspected stone in the extrahepatic biliary tree. The CT revealed the origin of a sizable cystic artery from the SMA. The MRCP showed that the right posterior hepatic (sectorial) duct (RPHD) drained at the confluence of the cystic duct to the hepatic duct.

She underwent open cholecystectomy due to severe gallbladder inflammation in the ground of these anatomical variations. Her postoperative course was uneventful, and she was discharged on the 2nd postoperative day.

DISCUSSION

There is an average of 24,5% of people who have variant origins of cystic artery, other than the common (75,5%) origin, which is the right hepatic artery (RHA). Although in this review most of the studies found that the main origin of the cystic artery is RHA, there is only one cadaveric study which reports that in 5% of cases the cystic artery originated from the SMA (Bekel, 2020).

In another imaging study of 256 cases, only two cases have been also reported where the cystic artery arose from SMA (Li et al., 2021). In the literature, only one case was also found of a cadaveric study of a cystic artery that arose from SMA, in an 86 years old woman (Yakura et al., 2017). The explanation for those variations in the origin of the cystic artery is found due to the specific developmental pattern of the biliary system. Embryologically, the branching pattern of the gastroduodenal and hepatobiliary vasculature is altered by the growth of both the liver and the pancreas. Four

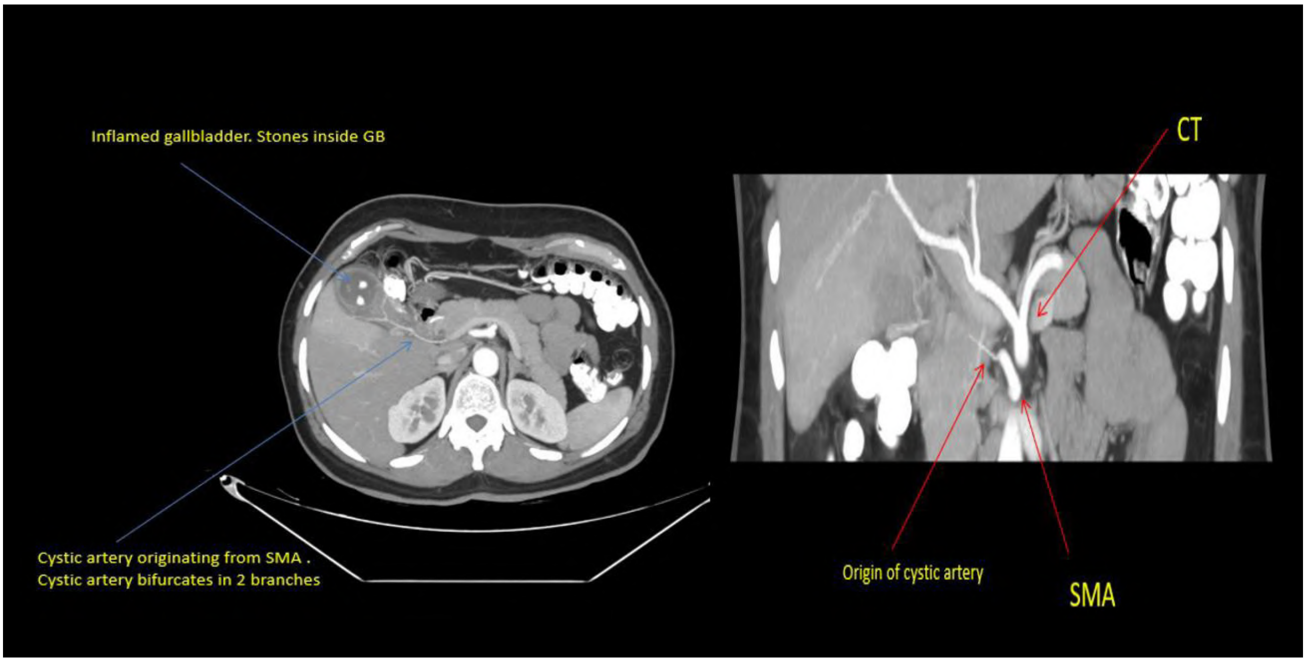

Fig. 1.- Left: CT scan which shows the inflammation of the gallbladder and the stones inside the gallbladder and the course of cystic artery. **Right**: CT scan which shows the origin of the cystic artery from the superior mesenteric artery. SMA: superior mesenteric artery, CT: celiac trunk.

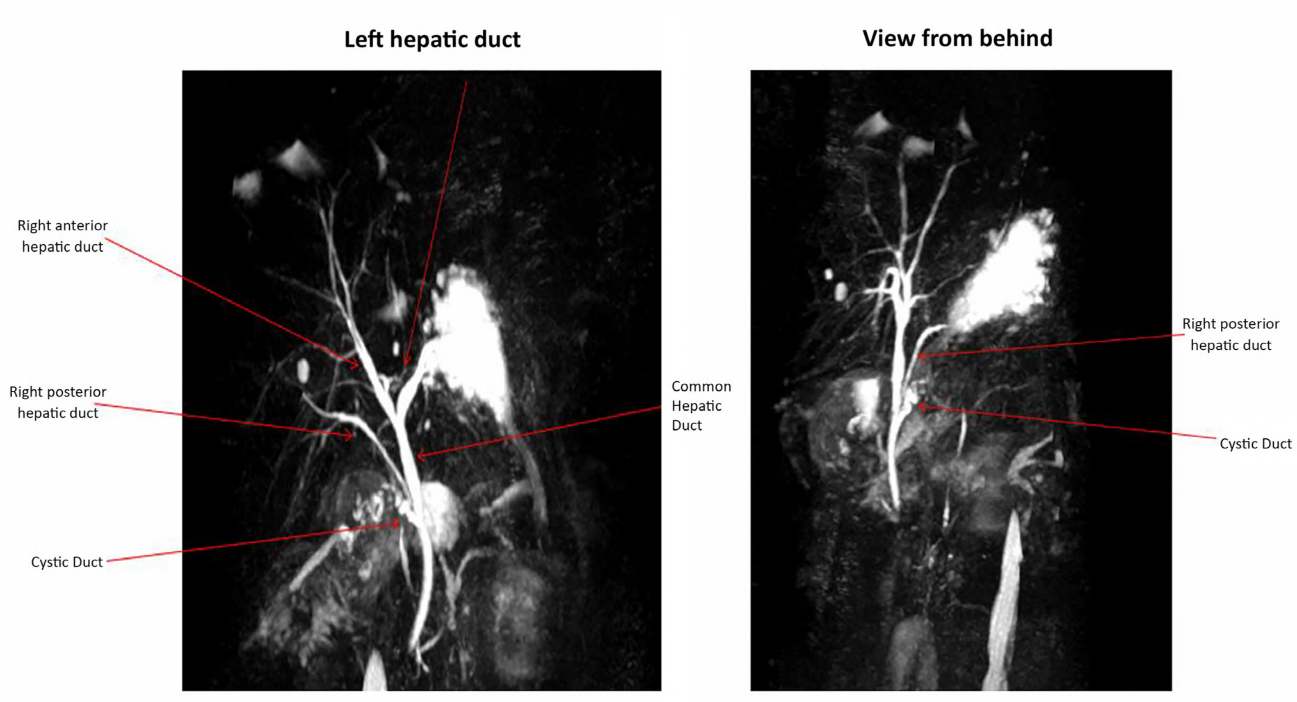

Fig. 2.- Left: MRCP that shows the right posterior hepatic duct draining into the common bile duct in conjunction with the cystic duct. **Right**: MRCP showing the same as in the left image but from a different angle.

primitive splanchnic branches arise from the abdominal aorta, but the central two disappear and the longitudinal anastomosis joins the first and fourth roots. The gastric, common hepatic, and splenic arteries originate at this longitudinal anastomosis. Variety of anomalies can occur from false retention or disappearance of parts of this primitive arterial plexus (Shuang-Qin et al., 2007). Moreover, considering that the liver is derived from a portion of the primitive duct supplied primordially by the celiac and mesenteric arteries, it may receive rami from both of these sources (Loukas et al., 2010). It is really important for the surgeon to be aware of all these variations and also to understand the problems they may cause in a cholecystectomy. Identification of the cystic artery intraoperatively might be challenging, because hemorrhage from an inadvertent injury of the cystic artery might be difficult to control in the ground of an inflamed gallbladder and surrounding tissues and force the surgeon to convert a laparoscopic cholecystectomy to an open one. This was one of the main concerns in our case in order to start the operation not laparoscopically but open.

The knowledge of embryology of biliary tree can explain the variations that exist. At the 5th week, the biliary tree is recognizable; up until the 6th week the common duct and ventral pancreatic bud rotate 180 degrees clockwise around the duodenum. At the 7th week, the bile and pancreatic ducts end in closed cavities of the duodenum, and at that time there is also a stimulation that causes hepatic cells to transfer into another cell type in order to create the duct cells and after all the tubule formation of the biliary tree (Hassan Gamal et al., 2013).

Some variation types may be close to our case, such as Type A5, which has an incidence approximately of 1,6% in an imaging study of 2,032 patients regarding variations in right hepatic duct (Chaib et al., 2014). In another cohort imaging study, ta similar type has been also described (4,5%), where the RPHD join the common hepatic duct after the right anterior hepatic duct (RAHD) and the left hepatic duct (LHD) has merged at the point at which the RPHD may be close to the confluence of the RA and LHD or more distal (Vakili and Pomfret, 2008). Similar also anatomic variation, where the RPHD joins below the confluence of the RAHD and LHD has been described in 8% of patients, in an imaging study of 200 people regarding anatomic variations in biliary tree (Cucchetti et al., 2011). The exact variation we present where the RPHD, the cystic duct and the common hepatic duct merge at the same point has not been described so far.

The surgeon should be aware of these variations in the biliary tree to avoid an inadvertent injury or ligation to the right posterior duct and subsequent bile leak, or atrophy of the right posterior liver sector, or cause a laparoscopic cholecystectomy to convert to open due to difficulty in understanding the anatomy of the patient. This unique variation was the second reason that the surgeon decided to perform an open cholecystectomy.

Either of the variations which presented or the combination of them like in our case, might complicate liver or pancreas procurement and liver transplantation or might complicate liver resections or biliary tract surgery, or a Whipple's operation, or a gastric resection for cancer with D2 lymph node dissection, or most commonly might complicate a simple laparoscopic cholecystectomy, especially when inflammation exists. When present, these variations should be reported by the radiologists when they notice them in imaging studies.

In our case, the patient with acute cholecystitis had a right posterior hepatic duct that drained at the confluence of the cystic duct with the common hepatic duct, and a cystic artery arose from superior mesenteric artery. To the best of our knowledge, no other cases with coexistence of the same anatomic variations have been reported so far to the literature.

CONCLUSION

The surgeon should be aware of these variations in order to avoid intra- or post-operative complications, and the radiologists should report these variations because they could have a significant clinical impact.

Authors' contributions

P.K.: data collection and manuscript preparation. E.L.: original idea and critical review of the manuscript. All the authors read and approved the final manuscript.

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