The Unusual Localization of Right Hepatic Artery Multiple Anatomic Variants in Celiac Axis

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ABSTRACT

The extrahepatic vascular and biliary anatomy of Calot's triangle is well known to be highly variable and this provides a surgical challenge. The liver has a dual blood supply consisting of the portal vein and the hepatic artery. The hepatic artery which delivers 25% of the blood supply, arises from the celiac trunk. The celiac trunk gives off the left gastric, splenic and common hepatic arteries. The common hepatic artery then divides into gastroduodenal artery and hepatic artery proper which diverts in right and left hepatic arteries. The systic artery usually originates from the right hepatic artery. The "classic" arterial anatomy is present in approximately 75% of cases. The remaining 25% of the cases have many anatomical variants. Here in we present a patient with multiple anatomic variants in celiac trunk which were determined incidentally during laparoscopic cholecystectomy. Being aware of the arterial variations in the liver is really important in surgical procedures in order to avoid bleeding and ischemia.

Key words: *Variation, right hepatic arter, celiac trunk*

Çölyak Aksda Sağ Hepatik Arterin Multipl Varyasyonunun Nadir Görünümü

ÖZET

Ekstrahepatik vasküler ve Calot's üçgeninin biliyer anatomisi oldukça değişken olduğu bilinmektedir ve bu cerrahi bir endişe oluşturur. Karaciğer portal ven ve hepatik arterin oluşturduğu ikili bir kan kaynağına sahiptir. Çölyak trunkusdan kaynak alan hepatik arter kan akımının % 25'ini sağlar. Çölyak trunkus, sol gastrik arter, splenik arter ve ortak hepatik arter dallarını verir. Daha sonra ortak hepatik arter; gastroduodenal arter ve hepatik arteri verir, hepatik arter de sağ ve sol hepatik dallara ayrılır. Sistik arter genellikle sağ hepatik arterden kaynaklanmaktadır. "Klasik" arteriyel anatomi vakaların yaklaşık% 75'inde mevcuttur. Olguların% 25'inde pek çok anatomik varyantlar vardır. Biz laparoskopik kolesistektomi sırasında tesadüfen tespit edilen Çölyak trunkusunda birden anatomik varyantları olan bir hastayı sunduk. Cerrahi işlemler sırasında kanama ve iskemiyi önlemek için karaciğer içinde arteriyel varyasyonları bilmek çok önemlidir.

Anahtar kelimeler: *Varyasyon, sağ hepatik arter, çölyak gövde*

INTRODUCTION

The liver is the largest gland in the body with extraordinary functions like storage, metabolism, production and secretion. Furthermore it has a great role in detoxification and immunologic functions. The liver has a dual blood supply consisting of the portal vein and the hepatic artery. The hepatic artery which delivers 25% of the blood supply, arises from the celiac trunk. The celiac trunk gives off the left gastric, splenic and common hepatic arteries. The common hepatic artery then divides into gastroduodenal artery and hepatic artery proper which diverts in right and left hepatic arteries. The systic artery usually originates from the right hepatic artery. The "classic" arterial anatomy is present in approximately 75% of cases. The remaining 25% of the cases have many anatomical variants (1). Although there are many studies about hepatic arterial variations con-

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cerning large groups of cases, the extrahepatic vascular and biliary anatomy of Calot's triangle is well known to be highly variable and this provides a surgical challenge. Because of this, each new description about vessels of the liver is important and critical to understand in order to avoid surgical complications when operating on liver, gallbladder, pancreas or any adjacent organs. Herein we present a patient who has an unusual hepatic artery localization with multiple anatomic variants in celiac trunk which were determined incidentally during laparoscopic cholecystectomy.

CASE

A 57-year-old female patient was admitted to our hospital with complaints of post-prandial epigastric pain and nausea for six months. Her physical examination and laboratory findings, including liver function tests, were unremarkable. The abdominal ultrasound revealed multiple gallstones without cholecystitis. The patient was scheduled for elective laparoscopic cholecystectomy. The operation was initiated with establishment of pneumoperitoneum and then standart trocars were replaced. During the exploration no adhesions were seen. After retraction of the gallbladder superolaterally, the calot's triangle was dissected. Ductus cysticus was dissected but a pulsating vascular structure larger than the cystic artery, was noticed. Ductus cysticus and choledochus were identified clearly and then cystic duct was clipped and ligated. The arterial structure which was larger than the cystic artery was dissected from the gallbladder carefully without clipping and ligating. The arterial structure was lying on the gallbladder up to the fundus and during its course it was giving off little branches to the gallbladder. Just near the fundus it divided into two branches and each entered the right hepatic lobe seperately. Afterwards the gallbladder was dissected from the liver carefully and removed. The followed arterial structure was probably the right hepatic artery, dividing into two branches and both of them were visibly travelling across the gallbladder bed and entering the liver at an unusual anterior location. The remain of the procedure was completed as an uncomplicated laparoscopic cholecystectomy. After the operation in order to clarify the vascular anatomy and variants, the patient was performed dual-phase helical computed tomography after injection of 100 ml non-ionic contrast medium (Ultravist 370, Bayer Schering Pharma AG, Germany) into a vessel with 5 ml/sec through an intravenous canula. Scanning was started 25 seconds after the initiation of contrast bolus. Images were reconstructed at every 1 mm intervals. It was seen that celiac trunk was divided into two main branches: common hepatic artery and splenic artery. But before this, celiac trunk gives off a branch just before this division as left hepatic artery. When this aberrant left hepatic artery was followed from the tomography images, a branch was noticed moving superiolaterally to the left and thought to be left gastric artery. Gastroduodenal artery was dividing from common hepatic artery but afterwards no proper artery was seen to be formed. After gastroduodenal artery junction, the remainder branch called right hepatic artery was seen and near it surgical clips were noticed which probably belonged to cystic artery. The continuing images showed that right hepatic artery was also divided into two branches and entered the right lobe seperately at an anterior location (Figure 1). The diameters of the arteries were calculated from tomography images and given in Table 1.

DISCUSSION

Studies of hepatic arterial anatomy during liver harvesting for transplantation provide an excellent database documenting anomalies. The "classic" or "standard" arterial anatomy is present in approximately 75% of the cases with the remaining 25% having variable anatomy (1). The most common variant is the right hepatic artery coming off the superior mesenteric artery in 18-22% of the cases which can be recognized visually on computed tomography or magnetic resonance imaging scan. Other aberrant right hepatic artery sources are the gastroduodenal artery, right gastric artery and aorta (2-4). A replaced (or accessory) left hepatic artery coming off

***Table 1**. The diameters of the arteries were calculated from tomography images*

	Diameter (mm)
Celiac trunk	*8.5*
Replaced left hepatic artery	*3.5*
Common hepatic artery	*5.4*
Splenic artery	*5.3*
Right hepatic artery	*4.5*
Replaced left gastric artery	*3.7*
Gastroduodenal artery	*2*
Right branch of right hepatic artery	*3.8*
Left branch of right hepatic artery	*3.5*

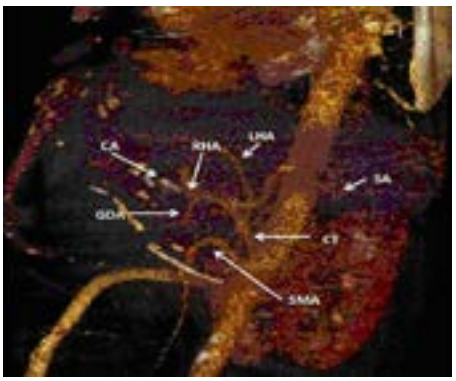

***Figure 1**. Dual-phase helical computed tomography image of celiac trunk (LHA, left hepatic artery; SA, splenic artery; CT, celiac trunk; GDA, gastroduodenal artery; RHA, right hepatic artery; CA, cystic artery-clipped; SMA, superior mesenteric artery)*

the left gastric artery can be seen in 12 to 15% of the cases. Other less common variants are (approximately 2% each) an early bifurcation of right and left hepatic arteries and completely replaced common hepatic artery comming off the superior mesenteric artery. The cystic artery usually arises from the right hepatic artery in about 80% of the cases but may arise from the left hepatic, common hepatic, gastroduodenal or superior mesenteric arteries (5). An international classification that describes the variations of the vascular anatomy of the liver was proposed by Michels in 1966 (6). It was modified by Hiatt et al. in 1996 (1) by a study on 1000 patients. Then, Koops et al. supplemented a new study on 604 patients in 2004 (7), and Abdullah et al. introduced a study on arterial variations on a group of 932 patients in 2006 (8). In spite of such accurate studies concerning large groups of patients, there are still some rare hepatic arterial variations not included in these classifications.

The embryology behind arterial variations in the liver has been subject of many studies (6, 9,10). The arterial supply of the liver during the foetal live came from the common hepatic artery, the right hepatic artery originating from the superior mesenteric artery and the left hepatic artery originating from the left gastric artery (8,10). Thus partial or complete persistence of the foetal pattern result in anatomical variations of vascularization of the liver. Miyaki's investigations (9) stated that the frequency of the right hepatic artery in foetuses was 18.3%, whereas Zahoi et al. showed (11) the frequency of this vessel in cadavers as 5%. Following the extensive studies it is now widely accepted that the origin of the accessory/ aberrant right hepatic artery is highly variable (1, 7,12). In our case, it was seen that celiac trunk gives off a branch as left hepatic artery just before the division. When this aberrant left hepatic artery was followed from the tomography images, a branch was noticed moving superiolaterally to the left and thought to be the left gastric artery. Then the trunk was divided into two main branches: common hepatic artery and splenic artery. Gastroduodenal artery was dividing from common hepatic artery but afterwards no proper artery was seen to be formed. After gastroduodenal artery junction, the remainder branch called right hepatic artery was seen and near it surgical clips were noticed which probably belonged to cystic artery. The continuing images showed that right hepatic artery was also divided into two branches and entered the liver seperately at an anterior location. We presented a replaced left hepatic artery, replaced left gastric artery, absence of hepatic artery proper and division of right hepatic artery with an unusual route, all in one patient. The diameters of the arteries presented in the case also shows that being aware of the arterial variations in the liver is really important in surgical procedures in order to avoid bleeding and ischemia. Inadvertent right hepatic artery ligation in cholecystectomy can be associated with liver ischemia, sometimes leading to hepatic lobectomy. An angiographic study will help to identify the anatomic variations however it is not usually clinically indicated preoperatively as in our patient. The size of the suspected vessel alone is sufficient in order to emphasize its significance during the operation.

This case serves as a reminder of the variations in extrahepatic vascular anatomy. The surgeon should always keep in mind that there are numerous anatomical possibilities both about vascular and bilier anatomy so careful dissection of the cystic duct and artery is required. The measurements of the diameters of the arteries confirm the importance of the vascularization of the liver. Dual phase computed tomography should play a critical role in the evaluation and identifying the hepatobiliar complex when indicated.

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