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Left Hepatic Artery Arising from the Superior Mesenteric Artery: A Case Study of a Rare Anatomic Variation

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Abstract: Knowledge of hepatic arterial vascularization and its variations have a significant relevance for the daily practice of hepato-biliary surgeon as well as radiologists. Human cadaver livers (n=60) were obtained from routine autopsies. Resections were carried out *en bloc* with liver, celiac trunk (CT), left gastric artery (LGA), lesser *omentum*, superior mesenteric artery (SMA) and head of the pancreas. We have found one case with an exceptional anatomic variation, replaced left hepatic artery (LHA) coming off the SMA directly to the hepatic left lobe. We would like to draw attention for this particularly anatomic variation of the origin of the LHA ensuring that no damage will be made during gastrointestinal surgery.

Keywords: Liver anatomy, left hepatic anomaly, superior mesenteric artery.

INTRODUCTION

Knowledge of hepatic arterial vascularization and its variations have a significant relevance for the daily practice, basically the classic arterial anatomy is seen in 55 to 77% of the population [1, 2]. Anatomical variations of the arterial supply of the liver are reported to occur in 25-50% of the total population [3].

The most common variations of the left hepatic artery (LHA) origin are: from left gastric artery (LGA) - 25% [4, 5], splenic and gastroduodenal artery - 4% [6] and directly from the aorta - 0.5- 2% [6-9].

Our goal is to highlight the importance of knowing the hepatic artery anatomy and its variations since we have found an exceptional replaced LHA arising from the superior mesenteric artery (SMA).

MATERIAL AND METHODS

Human cadaver livers (n=60) were obtained from routine autopsies. The cadavers and the livers had to comply with the following requirements: (1) minimum age 18 years old, (2) no liver pathology to be expected from medical history and, (3) no liver pathology noted at the autopsy.

The Research and Ethical Committee of the University of Sao Paulo School of Medicine approved the human cadaver research.

Resections were carried out *en bloc* with liver, celiac axis, left gastric artery, lesser *omentum*, superior mesenteric artery and pancreas head. An eventual left or right hepatic artery was thus taken down in continuity with the aorta. The liver was dissected free from its peritoneal attachments. The hepato-duodenal ligament was dissected as close to the duodenum as possible. The gallbladder, if present, was removed.

In the division of right and left lobes of the liver it was necessary to excise the caudate lobe (segment I). The cutting plane of the liver consisted of a longitudinal section made immediately on the left of the supra-hepatic inferior vena cava through the gallbladder bed preserving the arterial, portal and biliary branches in order to obtain two viable grafts (right lobe - segments V,VI,VII,VIII and left lobe - segments II,III,IV) as defined by the main portal *scissure*. The hepatic artery was dissected out and recorded carefully when the liver was split in right and left lobe.

RESULTS

We have found right and left hepatic artery in 45(75%) cases; replaced or accessory LHA arising from the LGA in 9(15%) cases; replaced or accessory right hepatic artery (RHA) originating from the SMA in 4(6.6%) cases; the right hepatic artery coming from the SMA in 15 (25%) cases; the left hepatic artery originating from the LGA in 2 (3.3%) cases; the entire CHA arising as a branch of the SMA in 1 (1.6%) case; the CHA originating directly from the aorta in 11(18.3%) cases; accessory RHA from SMA and replaced LHA from LGA in 3(5%) cases; replaced RHA and LHA from SMA in 1(1.6%) case; LHA arising directly from the aorta in 1(1.6%) case.

One case had an exceptional anatomic variation, replaced LHA coming off the SMA directly to the hepatic left lobe (Fig. **1**).

DISCUSSION

Anatomical variations of the arterial supply of the liver are not uncommon. Only half of the cases in anatomical

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studies have the typical normal anatomy of the hepatic artery [10, 11]. Some of the variations such as the presence of a right or left hepatic branch arising from SMA and LGA respectively are more common, but others also relating to blood supply of the liver are extremely rare [12, 13].

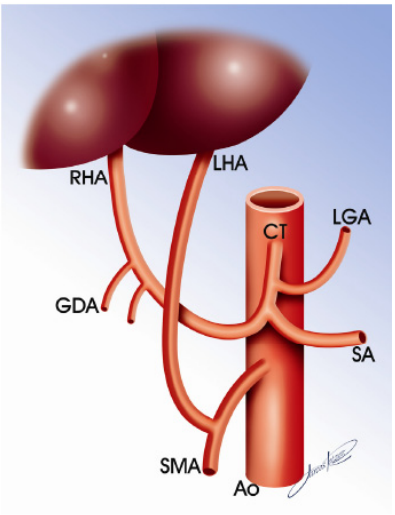

Fig. (1). Left hepatic artery coming off the superior mesenteric artery passing the hepatic hylum posteriorly to the common hepatic artery, heading upwards getting into the liver through the segment IV. RHA-right hepatic artery;GDA-gastroduodenal artery;SMA-superior mesenteric artery;SA-splenic artery;LGA-left gastric artery;CT-celiac trunk; LHA-left hepatic artery.

Michels [5] reported a classification of 10 possible anatomical variants of the extra-hepatic arterial distribution that was based on a study of 200 autopsy cases. From a surgical point of view the classification is more complete since it establishes the differences between "an accessory" and "a replaced" artery, concepts not explained in more recent classifications.

Replaced hepatic arteries are anomalies that are easily managed, in contrast, the presence of accessory arteries might result in reconstructions of double arteries that, because of their small diameters, are the cause of an increased rate of arterial thrombosis in liver transplantation procedure despite the use of refined suture techniques [14, 15].

This study found that the LHA arose from the LGA in 10 (16.6%) cases, according to literature replaced or accessory LHA range from 9.7 to 12% [16]. In one (1.6%) case the CT arose from the SMA, this specific anatomical variation range from 1.1 to 1.5% [16].

LHA originating directly from the SMA as replaced artery is extremely rare anatomic variation, its incidence when originated from aorta range from 0.5 to 2% [12, 13]. Abdominal arteries arising from the superior mesenteric artery is shown in the Table **1**. Moreover, the hepatic artery arising from the hepatic-mesenteric trunk and crossing the portal vein anterior to it has been described elsewhere [13].

Embryological CT and the SMA may have a common origin from the aorta (incidence approximately 1%) or the trunk may have become a fibrotic string [4, 9]. The arc of

Table 1. Literature Review of the Liver and Abdominal Arteries Arising from the Superior Mesenteric Artery

Author	Year	Findings	Comments
Abdullah *et al.* [19]	2006	RHA	932 LTD
Almenar-Garcia *et al.* [20]	1993	AcRHA	Case report
Arjhansiri *et al.* [21]	2006	RHA	200 angiography
Covey *et al.* [22]	2002	PHA	600 angiography
Gruttadauria *et al.* [23]	2001	RHA	701 LTD
Hiatt *et al.* [24]	1994	RHA	1000 LTD
Huu *et al.* [25]	1976	GDA	400 cadaver dissection
Iimura *et al.* [13]	2007	CHA	Case report
Jones & Hardy [26]	2001	RHA	180 LTD
Koops *et al.* [27]	2004	RHA	604 LTD
López-Andújar *et al.* [28]	2007	RHA	1081 LTD
Nagino *et al.* [29]	1993	RAHA	Case report
Nayak *et al.* [30]	2008	IPDA	Case report
Osawa *et al.* [31]	2004	CHA and IMA	Case report
Pendarvis *et al.* [32]	1997	RA	Case report
Ray *et al.* [33]	1998	LGA	Case report
Sakamoto *et al.* [34]	1999	RGEA	Case report
Yi *et al.* [35]	2008	IMA	Case report

RHA- right hepatic artery; AcRHA-accessory right hepatic artery; PHA- proper hepatic artery; GDA-gastroduodenal artery; IPDA- inferior pancreatico-duodenal artery; CHA-common hepatic artery; RAHA- right anterior hepatic artery; IMA-inferior mesenteric artery; RA- renal artery; LGA-left gastric artery; RGEA-right gastroepiploic artery; LTD- liver transplantation donor.

Buhler, i.e. a link vessel between the hepatic artery and the SMA, is not so unusual [4, 10], a seemingly more extraordinary situation is the case where a strong communicating artery between the CT and the SMA was found, on the other hand the RHA off the SMA occurs in up to 20% of all cases [2].

According to the theory of Tandler [17], the CA and the SMA develop as cephalic roots of vitelline or omphalo-mesenteric arteries, which are joined with a ventral para-aortic anastomosis between the 4th and 7th gestational weeks.

The embryological development of the liver starts in the 3rd gestational week as a hepatic diverticulum of the foregut [18]. The dorsal arteries join to form the aorta, from which paired branches provide a supply of blood to both the foregut and the liver bud. Since the primitive vitelline arteries form the CT and the SMA, one of these paired branches to the left of the foregut seems to have persisted in our case, creating a branch that irrigate the left lobe of the liver.

In conclusion, we would like to draw attention for this particularly anatomic variation of the origin of the LHA ensuring that no damage will be made during gastrointestinal surgery.

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