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Case Report

Symmetrical variations in the branching pattern of abdominal aorta: a case report

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Abstract

During routine cadaveric dissection, we came across a combination of arterial variations in the branching pattern of abdominal aorta. First, both the renal arteries were accompanied by accessory renal arteries, which were bilaterally symmetrical in the following respects: (i) the accessory arteries were related anterior to the main trunk of renal arteries, (ii) they gained entry into the kidney through the hilum (anterior to the hilar structures), and (iii) they exhibited a similar branching pattern inside the substance of the kidney. Second, both the inferior phrenic arteries were arising from the celiac trunk, instead of the abdominal aorta and were slightly more tortuous than usual. Presence of such major variations assumes great clinical importance for interventional radiological procedures. Moreover, all major abdominal surgeries, including oncologic resections (of pancreas and liver) and renal transplantation demand an accurate account of any variations in the vascular apparatus.

Key words [abdominal aorta] [renal artery] [inferior phrenic artery] [celiac trunk] [symmetrical]

Introduction

Information regarding anatomical variations in the branching pattern of great vessels of the abdomen, including abdominal aorta, celiac trunk, mesenteric and renal arteries is imperative for planning surgical procedures and interpreting interventional radiological imaging. In fact, liver and kidney transplantations and oncologic resections require major vessels ligation. Background knowledge of the possible vascular variations in the branching pattern of aorta could prove to be life saving during such procedures [1].

The abdominal aorta continues from thoracic aorta at the median aortic hiatus in the diaphragm, at the level of lower border of 12th thoracic vertebra. Classically, 3 ventral branches –celiac trunk, superior mesenteric artery and inferior mesenteric artery– arise from it and supply foregut, midgut and the hindgut, respectively. The first ventral branch, the celiac trunk arises at T12-L1 level. The second and third ventral branches are the superior mesenteric and inferior mesenteric arteries, which usually originate at L1 and L3 vertebral levels, respectively. The lateral branches of the aorta, i.e. renal arteries and gonadal vessels supply the urogenital system. The posterolateral branches –inferior phrenic arteries and the lumbar arteries– supply the body wall, inferior aspect of the diaphragm and posterior abdominal wall [2].

The celiac trunk is about 1.25 cm long, passes almost horizontally forwards. It divides into left gastric, common hepatic and splenic arteries. However, variations in this branching pattern have been reported. It may also give off one or more of the inferior phrenic arteries.

Classically, renal artery arises from each side of the abdominal aorta. Renal artery variations are divided into 2 groups: early division and extra renal arteries (ERA). Branching of the main renal arteries into segmental branches more proximally than the renal hilar level, is called early division. ERAs are divided into 2 groups: hilar (accessory) and polar (aberrant) arteries. Hilar arteries enter kidneys from the hilum with the main renal artery, whereas polar arteries enter kidneys directly from the capsule outside the hilum [3]. The frequency of ERAs is generally between 25-30% in anatomic and cadaver studies [2].

Case Report

During routine cadaveric dissection of a 58-year-old male, we came across a combination of arterial variations in the branching pattern of abdominal aorta. After fine dissection, measurements were taken and photographed.

Firstly, renal arteries were accompanied by accessory renal arteries bilaterally. The accessory arteries originated from the abdominal aorta 0.5 cm above the origin of the main renal

artery. They were related anterosuperior to the main trunk of renal arteries. The main renal artery on either side was related posterior to the renal vein, whereas the accessory renal artery was related anterior to the renal vein. Their caliber was lesser than that of the main renal arteries. They gained entry into the kidney through the hilum (anterior to the hilar structures). Both the accessory arteries exhibited a similar branching pattern inside the substance of the kidney (Figure 1).

Secondly, inferior phrenic arteries were originating from the celiac trunk instead of the abdominal aorta. The right and left inferior phrenic arteries coursed superolaterally on each side, from the celiac trunk and were distributed on the inferior (abdominal) surface of the diaphragm (Figure 1). Despite the deviant origin of the inferior phrenic arteries, their branching pattern was normal. Thus in this case celiac trunk gave five direct branches, namely: a pair of inferior phrenic arteries, left gastric, common hepatic and splenic artery, instead of three branches. The other branches of abdominal aorta showed the usual origin and course.

Discussion

The variations in branches of abdominal aorta are of immense clinical importance. The presence of anatomical variations in renal vasculature does not affect the normal functioning of the kidney. But it influences the predisposition to certain diseases like renovascular hypertension. It is also of significance in surgical procedures like renal transplantation, vascular reconstruction, endoscopic surgeries, management of renal trauma [1]. The accessory renal arteries are end arteries, and if ligated, the part of kidney supplied by it is likely to become ischemic. The post-operative complication rate in renal transplant is higher with kidneys having accessory renal arteries [4]. The inferior phrenic arteries supply many organs including the diaphragm, adrenal glands, esophagus, stomach, liver, inferior vena cava, and retroperitoneum. This artery is a major source of collateral or parasitized arterial supply to hepatocellular carcinoma, second only to the hepatic artery [5]. Hence, transcatheter embolization of the inferior phrenic arteries, if involved, is performed in unresectable hepatocellular carcinomas.

The presence of accessory renal arteries can be explained on the basis of embryological development. The lateral mesonephric arteries originate from the dorsal aorta and supply the developing mesonephros, metanephros, suprarenal glands and gonads. These arteries can be divided into three groups: the 1st and 2nd arteries as the cranial group, the 3rd to 5th arteries as the middle group, and 6th to 9th arteries as the caudal group. The middle group gives rise to renal arteries. The cranial vessels in this network degenerate. Persistence of more than one renal arteries of the middle group results in multiple renal arteries [6]. As the metanephros ascends from the pelvic to the lumbar region, it is supplied by arteries from the aorta at increasingly higher levels. Ultimately, the metanephros reaches the lumbar region where it is supplied by definitive renal arteries arising from the aorta at the level of second lumbar vertebra [7].

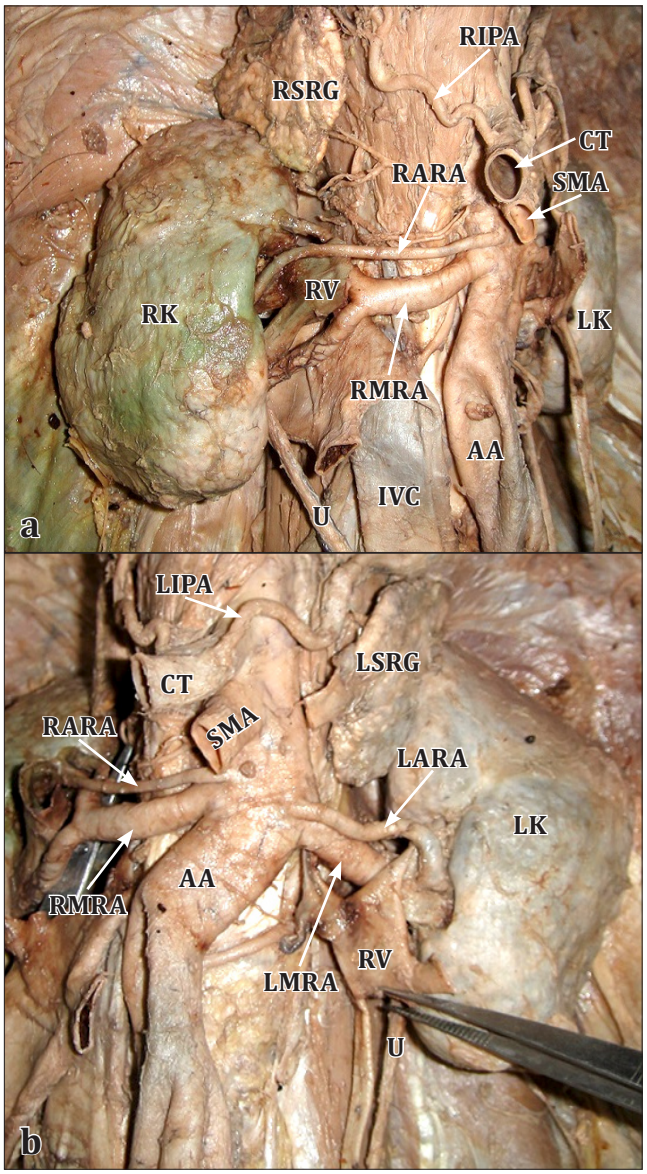

Figure 1. Figure showing the accessory renal artery arising from abdominal aorta and inferior phrenic artery arising from celiac trunk. **a)** Right side, **b)** Left side. *(**RK**: right kidney; **LK**: left kidney; **RSRG**: right suprarenal gland; **LSRG**: left suprarenal gland; **RV**: renal vein; **AA**: abdominal aorta; **IVC**: inferior vena cava; **CT**: celiac trunk; **SMA**: superior mesenteric artery; **U**: ureter; **RMRA**: right main renal artery; **LMRA**: left main renal artery; **RARA**: right accessory renal artery; **LARA**: left accessory renal artery; **RIPA**: right inferior phrenic artery; **LIPA**: left inferior phrenic artery)*

A study conducted on 130 patients and 74 human cadavers showed that additional arteries occurred more frequently on the left. The incidence bilaterally was 10.2% (first additional arteries only) [8]. Another study showed that accessory renal arteries were found frequently on the left side and occurrence

is as high as 30–35% of cases. These arteries usually enter at the poles [9]. In our case study, we found bilateral accessory renal arteries. These were hilar arteries that have a less common occurrence.

A study has reported the origin of inferior phrenic artery from abdominal aorta in 55% (R) and 65% (L), from celiac trunk in 35%(R) and 30% (L), and from the renal arteries in 10%(R) and 5%(L) of the cases. The artery for the two sides originated as a common trunk in 66.6% cases [10]. However, in a radiographic study in 383 patients the incidence of origin of inferior phrenic artery was: celiac trunk 39.7%, abdominal aorta 38.6%, renal artery 15.4%, and less commonly from left gastric, hepatic, superior mesenteric and even contralateral inferior phrenic artery [11]. In our case, we found the inferior phrenic arteries arose from the celiac trunk as independent branches.

A thorough knowledge of such possible variations is required to prevent complications during surgery. Our case report throws light on the same. It will be of use to the clinicians, researchers and anatomists. We recommend that the surgeons and radiologists pay consideration to these variations before planning any procedures.

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