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Abstract

Anatomical variations of the digestive system arteries are important due to their clinical significance. However, anomalies in the inferior mesenteric artery (IMA) are the least common compared with the celiac trunk and superior mesenteric artery. This report describes the case of a 67-year-old man with an extremely rare variant in which the IMA arises from the left common iliac artery, and the ipsilateral external iliac artery has a corkscrew pattern. These findings were depicted during computed tomography angiography of the abdomen and pelvis. This case is the first report of such a variation associated with a left external iliac artery turning into a double loop before forming the femoral artery. The embryological and clinical significance of such an anomaly are discussed.

Keywords

inferior mesenteric artery, corkscrew external iliac artery, arterial anomaly

Introduction

There are 3 major unpaired branches of the abdominal aorta supplying the gastrointestinal tract; the celiac trunk (CT) arising just below the aortic hiatus at the level of thoracic (T) 12 to lumbar (L) 1, the superior mesenteric artery (SMA) arising at the level of L1, and the inferior mesenteric artery (IMA) arising at L3. The CT and SMA show frequent and diverse anomalies in their origin and course, while the IMA is the most regular with the least encountered variations.¹⁻⁴ This article reports an extremely rare origin of the IMA along with other vascular anomalies encountered during the investigation of a patient.

Case Report

A 67-year-old man presented to the emergency department with acute abdominal pain. Mesenteric ischemia was suspected and a computed tomography angiography of the abdomen and pelvis was performed. The images showed unusual patterns of vascularization of the gastrointestinal tract along with a redundant large bowel.

The aortic bifurcation appeared high riding, located at L2 to L3 level. The CT was absent; each of the splenic and left gastric arteries arose independently from the aorta, whereas the common hepatic artery branched from the superior mesenteric artery (Figure 1A).

Moreover, a large trunk, whose branching pattern was that of the IMA, arose from the left common iliac artery (Figure 1A) with an ascending branch supplying the splenic flexure, descending and sigmoid colon as well as the rectum.

In the pelvis, the left external iliac artery turned into a double loop before forming the common femoral artery (Figure 1B). Only a rudimentary internal iliac artery was observed arising distally to its expected origin close to the sciatic notch (Figure 1C). In addition, a redundant and mobile sigmoid colon was noted.

Discussion

The literature is rich in reports describing vascular abdominal anomalies, in particular those pertaining to the gastrointestinal tract.⁵ However, this report describes an unusual origin of the

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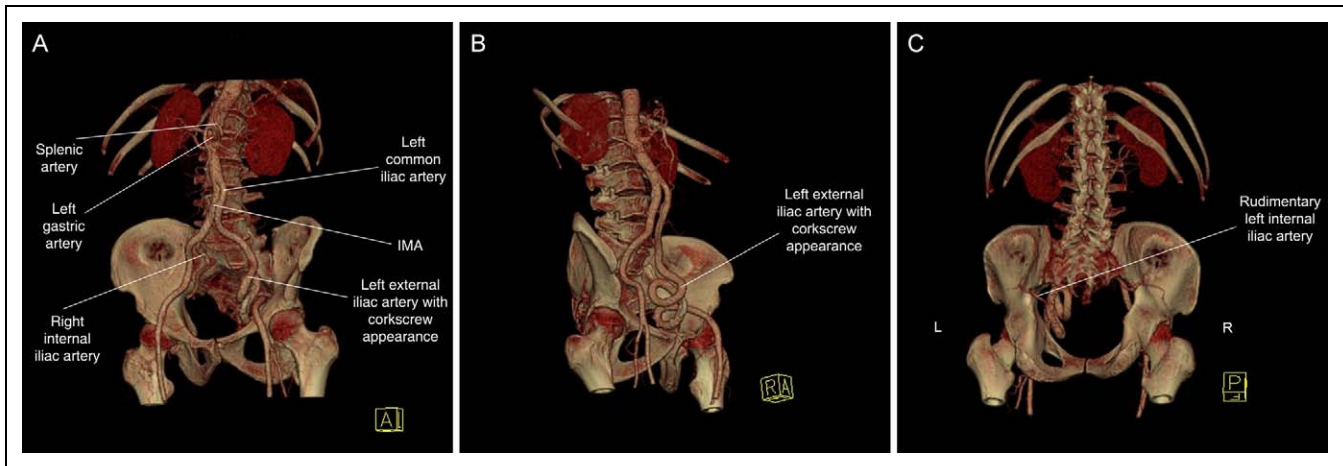


Figure 1. Three-dimensional reconstructed images showing the high riding aortic bifurcation at L2-3. The celiac trunk is missing, and the splenic and left gastric arteries arise independently from the aorta. A, The inferior mesenteric artery originates from the left common iliac artery. B, The left external iliac artery turns into a double loop before forming the common femoral artery giving a corkscrew appearance. C, The left internal iliac artery is rudimentary arising distally to its expected origin close to the sciatic notch.

IMA from the left common iliac and a corkscrew external iliac. This unusual origin of the IMA is an extremely rare variation, reported once in the literature in 1736 by Petsche, cited by Hyrtl in 1878 and compounded by Bergman et al, in 1988.^{6,7}

Normally, the CT whose length varies between 8 and 40 mm divides into 3 branches in 86% of cases and may be absent in 0.4%.⁸ When absent like in this case, the branches usually arising from it then arise separately from the aorta or nearby SMA.^{9,10} It can also merge with the SMA in a common trunk, the celiomesenteric trunk, or even with both the superior and the inferior mesenteric arteries forming the celiac–bimesenteric trunk.^{11,12,13} On the other hand, other CTs with 4 or 5 branches have also been reported.⁵

Moreover, the SMA has numerous variations. Duplicate SMA has been reported, and it may give rise to branches normally derived from other sources like CT or IMA. It can also provide accessory branches to the liver, stomach, pancreas, spleen, and gallbladder. In this patient, the SMA gave the common hepatic artery. In some cases, it gives the left colic and superior hemorrhoidal arteries, partly or completely replacing the IMA.^{5,7}

The IMA has the least variations among the 3. Duplicate IMA, an extremely rare variation, was reported by Benton and Cotter in 1963.¹³ The IMA has also been reported to arise from the SMA.^{9,14-17} In addition, the expansion of the supply territory of IMA was also described as giving rise to middle colic or accessory hepatic or by being common to both umbilical arteries.^{7,18-21}

The IMA, like in this report, could also arise in extremely rare cases from the left common iliac artery.^{5,6} What is unique in this case is the additional finding of corkscrew-like course of the external iliac artery ending up in a femoral artery.

Embryological Basis of This Variation

In this patient, multiple vascular anomalies existed together. A review of the embryology of the vascularization of the

gastrointestinal tract could probably help in understanding and explaining their origin. It is well established that the vitelline arteries to the yolk sac give rise to the arterial supply of the gastrointestinal tract. During development, as the yolk sac shrinks relative to the folding embryo, the right and left vitelline plexuses coalesce to form a number of major arteries that anastomose both with the vascular plexuses of the future gut and with the ventral surface of dorsal aorta, by a dynamic process of consolidation and reduction. Normally, these vessels eventually lose their connection with the yolk sac, anastomose with the dorsal aorta, and become the arteries that supply blood from the dorsal aorta to the gastrointestinal tract.^{2,22}

Caudal to the diaphragm, 3 major arteries develop to supply specific regions of the developing gut. The vitelline artery is the CT, which initially joins the dorsal aorta at the seventh cervical level and subsequently descends to the 12th thoracic and first lumbar levels. The CT vascularizes the abdominal part of the foregut from the abdominal esophagus to the descending segment of the duodenum, in addition to several embryologic outgrowths of the foregut including the liver, pancreas, gallbladder, and spleen.²²

The second abdominal vitelline artery is the SMA. It initially joins the dorsal aorta at the second thoracic level and later migrates to the first lumbar level. It supplies the developing midgut, from the descending segment of the duodenum to the left colic flexure of the transverse colon.²²

The third abdominal vitelline artery, the IMA, initially joins the dorsal aorta at the 12th thoracic level and later descends to the third lumbar level. It supplies the hindgut which includes the transverse colon, descending colon, sigmoid colon, rectum, and the superior portion of the anal canal. The above-mentioned vascular developments take place, in general, during organogenesis.²²

By the fifth week of development, rapid elongation of the ileum produces primary intestinal loop that herniates into the umbilicus. The herniated primary intestinal loop undergoes

an initial 90° counterclockwise rotation around the axis of the superior mesenteric artery, completed by the early eighth week. The midgut retracts into the abdomen and rotates another 180° counterclockwise during the 10th week of development. Consequently, the retracting colon has travelled a 270° circuit relative to the posterior of the abdominal cavity. Furthermore, in the descending colon, there is shortening and fusion of the mesentery with the peritoneum of the posterior abdominal wall. Thus, the descending colon becomes permanently anchored in a retroperitoneal position, while the rotation of the gut is processing with the relative lengthening of the lumbar region of the dorsal body wall.²² Probably, this anchorage did not completely happen in our patient.

Normally, the development of the gut and its respective vasculature are very well coordinated in space, position, and time, in particular during organogenesis where the gut rotation and herniation are taking place by a dynamic process of consolidation and reduction along with respective blood supply.²² The encountered anomaly in the origin of the inferior mesenteric artery from the common iliac artery probably happened during organogenesis by a default in this process of consolidation and reduction induced or caused probably by a delayed retraction of herniation of the intestinal loop. Such deformation, resulting from mechanical forces or disorganized retraction and rotations, could lead to the closure of some unusual channels of the vitelline arterial plexus destined to become the CT or the IMA, and as a compensatory mechanism was established, the sprouting by nearby channels of the plexus to carry on the task of blood supply and survival of organs.

The portion of the mesentery attached to the hindgut is also likely to play a role in this rotation and retraction. If retractions were delayed, the rotation of hindgut could happen without the secondary fusion of the vessels and descending colon (DC) to the dorsal body wall. The high bifurcating vessels will allow the free rotation of the vessels supplying the hindgut DC, sigmoid and partly rectum and anus. Such rotation of vessels leads to a corkscrew positioning of the vessels around the hindgut. Such variations in the developmental process could also lead to the choice of unusual paths in the primitive vascular plexus leading to the formation of the anomaly in the IMA and other arteries in the abdomen. Various factors interplay (1) persistence of vessels normally obliterated and (2) the disappearance of vessels normally retained. In addition, there was probably (3) incomplete fusion of the 2 dorsal aortas leading to early bifurcation and incomplete development, or (4) fusions and resorptions of vessels usually distinct under normal conditions.

In conclusion, the vitelline arterial plexus, most likely, did not have the proper leverage to rotate and retract properly. It could be mostly a delay of retraction for environmental (space, position) factors, that the arterial plexus was not probably able to differentiate normally to provide the proper anastomosis with the dorsal aorta at the proper site (L3 level) for IMA or the root of CT at T12-L1 during the 270° rotation. The compensatory mechanism for survival came from a nearby communication with the available part of the aorta, which is IMA from the

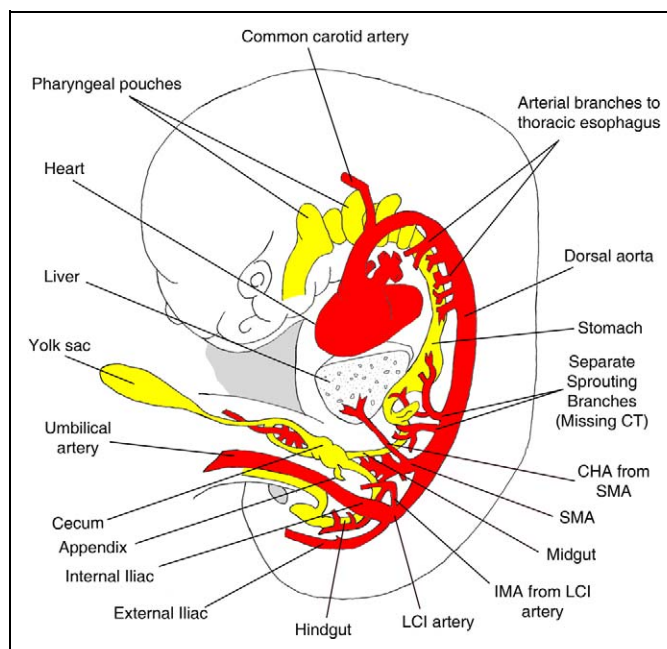


Figure 2. schematic diagram demonstrating the probable embryologic development of the ventral aortic branches in our patient. The celiac trunk (CT) is missing, and alternatively, there are separate sprouting splenic artery and left gastric artery branches. The common hepatic artery (CHA) arises from the SMA. The inferior mesenteric artery (IMA) arises from the left common iliac (LCI) artery. Modified from Larsen²² to apply to our patient.

left common iliac artery and the common hepatic from the SMA (Figure 2), in addition to a rotation of the bowel with the corresponding vessels, leading to the corkscrew appearance.

Clinical Significance

All variations in vascular anatomy may have implications for both the diagnosis and management of intra-abdominal disease. The change in vascular territories may impact the incidence or extent of ischemic conditions of the bowel, for example; whereas unusual patterns encountered during surgical procedures may pose difficulties or lead to undesirable complications. With the increasing use of endovascular management of vascular disease awareness of the possible variations in the origin of the IMA is important in planning and performing procedures. The corkscrew pattern of the external iliac would have hindered the vascular approach from this side.

In conclusion, the rare anomalous IMA origin and associated corkscrew pattern of the external iliac artery are to be added to the more common anatomical variations.

Declaration of Conflicting Interests

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