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Research article – Human anatomy case report

Direct origin of the right colic artery from the abdominal aorta

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Abstract

An isolated right colic artery originating directly from the abdominal aorta was incidentally observed during diagnostic spinal angiography. Variations in origin of the right colic artery are reviewed, and their embryology and potential clinical implications discussed.

Key words

Vascular anatomy, angiography, mesenteric arteries, colic arteries

Introduction

The subdiaphragmatic portion of the gastrointestinal tract is vascularized by three main arterial trunks corresponding to its embryological division in foregut, midgut, and hindgut. These vessels are the coeliac trunk, the superior mesenteric artery, and the inferior mesenteric artery. The right colic artery is a branch of the superior mesenteric artery supplying the ascending colon, which typically divides into ascending and descending branches respectively anastomosed with the middle colic and ileocolic arteries. The right colic artery is usually found deep to the parietal peritoneum on its way to the ascending colon, which has a retroperitoneal position due to the embryological fusion of its mesentery with the peritoneal lining of the dorsal body wall. We report here the observation of a right colic artery originating directly from the abdominal aorta as an isolated vessel.

Case report

The patient was a 71-year-old man presenting with progressive myelopathy. Spinal angiography, prompted by the suspicion of a spinal vascular malformation by magnetic resonance imaging, was unremarkable. Incidentally, a right colic artery (RCA) was seen originating as an isolated branch from the right anterolateral aspect of the abdominal aorta at the L2 vertebral level (Figure 1A). The RCA established an anastomotic connection with the right inferior phrenic artery, which branched off a right superior adrenal artery, while smaller adrenal contributions were coming from the RCA itself (Figure 1B,C). Normal L1 and L2 intersegmental arteries were documented on both sides. The vascularization of the gastrointestinal tract, being irrelevant to the patient's condition, was not investigated further.

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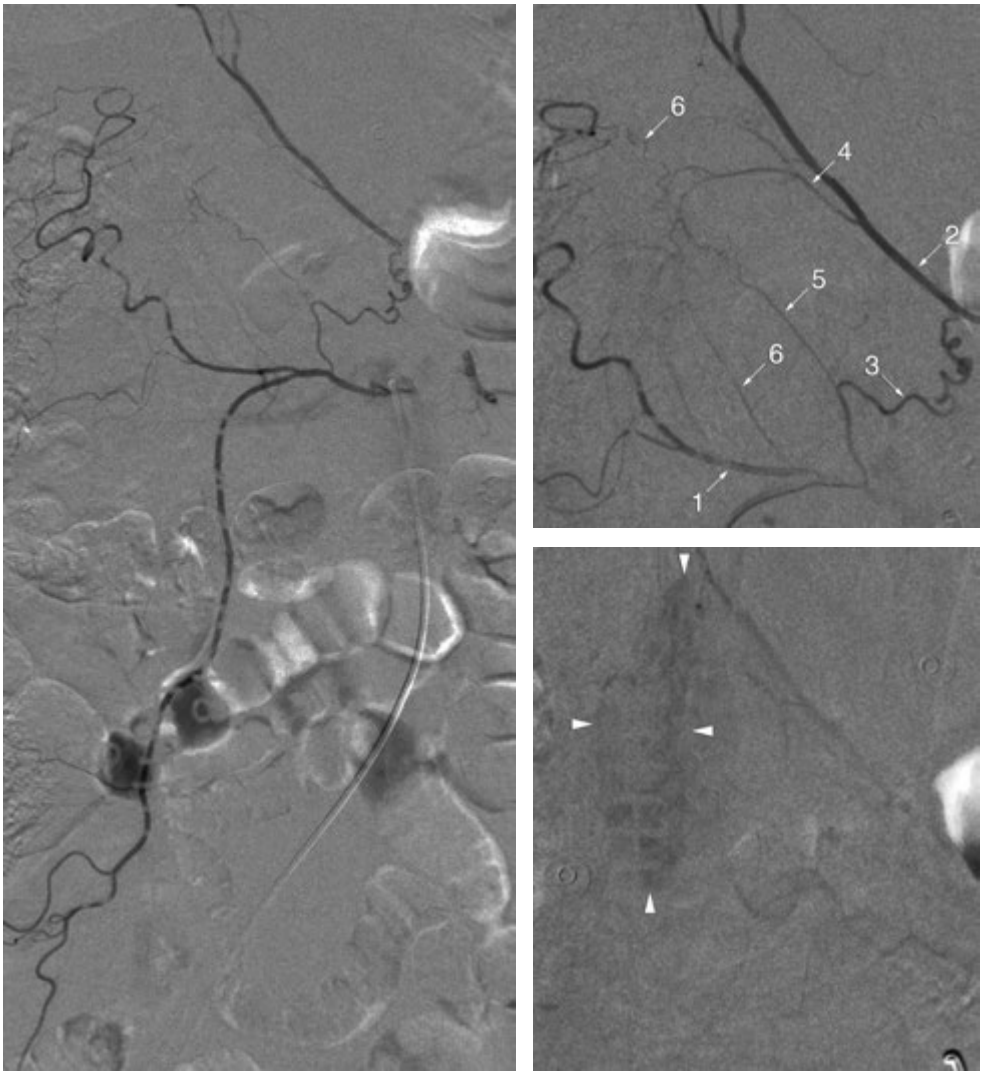

Figure 1 – Isolated origin of the right colic artery (RCA) from the aorta in a 71-year-old man. **A**: selective injection, posteroanterior view. The RCA typically divides into ascending and descending branches. An anastomotic connection with the right inferior phrenic artery is noted. **B**: selective injection, posteroanterior view. This magnified view offers a more detailed appreciation of the connection between the RCA and the right inferior phrenic artery. The latter provides a superior adrenal artery, while a middle adrenal artery stems from the anastomotic channel. Smaller adrenal branches are seen coming from the ascending branch of the RCA. 1 - ascending branch of the RCA, 2 - inferior phrenic artery, 3 - anastomotic channel, 4 - superior adrenal artery, 5 - middle adrenal artery, 6 - small adrenal branches**. C**: same injection and same view as **B**, delayed phase, showing the adrenal blush (arrowheads), located medially to the ascending branch of the RCA.

Discussion

Right colic artery variations

In a decreasing order of frequency, the RCA originates from the superior mesenteric artery (SMA) as a common trunk with the middle colic artery, as a separate branch from the SMA, or as a branch of the ileocolic artery. The RCA may be absent in up to 50% of cases (Garcia-Ruiz et al., 1996; Yada et al., 1997; Standring, 2008; Spasojevic et al., 2011). In spite of an extensive literature review that included classic anatomical textbooks as well as relevant anatomical and radiological journals, no prior description of an isolated RCA emerging directly from the aorta could be found. This variant does not appear in works specifically dealing with angiographic anatomy (Reuter et al., 1986; Kadir, et al., 1991; Boijsen, 1997) or with arterial variations (Adachi, 1928; Lippert and Pabst, 1985).

Embryology

The primitive vessels arising from the paired dorsal aortas are divided into three categories: (i) dorsal somatic intersegmental branches supplying the neural tube and body wall, (ii) lateral splanchnic segmental branches vascularizing the mesonephros, and (iii) ventral splanchnic segmental branches for the digestive tube. The latter group supplies the capillary plexus located in the roof of the yolk sac, itself composed of the endoderm from which the gastrointestinal tract will derive. Following the fusion of the dorsal aortas and the growth of the embryo, the longitudinal distance separating the origin of each pair of ventral splanchnic branches increases, particularly below the diaphragm. At the adult stage, only three subdiaphragmatic ventral aortic branches persist, the coeliac trunk and the two mesenteric arteries.

After the early development of the primitive dorsal, lateral, and ventral aortic branches, the sprouting of additional arterial stems is prevented by the growth of a layer of mesenchyma around the aortic wall. A capillary network, described by Jeidell (1911), forms beyond this mesenchymal wall and interconnects all the primitive aortic branches. This network participates in the vascularization of the surrounding organs. As the periaortic mesenchyma develops further, only functionally important connections between the aorta and the visceral capillary network remain patent; these connections will form the principal aortic stems and their branches at the adult stage (Jeidell, 1911; Bremer, 1915). The persistence of a portion of the network of Jeidell can result in the formation of anastomoses between the main aortic trunks, for example between the coeliac trunk and SMA, so called arc of Bühler (Bühler, 1904).

A similar developmental mechanism is likely at the origin of the isolated RCA described in this report. The portion of the vascular plexus destined to form the RCA may become attached to the aorta rather than to the SMA through the persistence of an alternate periaortic pathway, which can potentially involve any of the primitive aortic branches (ventral, lateral, or dorsal). The connection seen between the RCA and the right inferior phrenic artery, which is similar in nature to an arc of Bühler, represents another example of anastomosis resulting from the persistence of a portion of the primitive periaortic network. The right inferior phrenic artery normally originates as an isolated vessel from the aorta or as a branch of the coeliac trunk, the right renal

artery, the left gastric artery, or the hepatic artery (Loukas et al., 2005). Right inferior phrenic artery origin from the T12 or L1 intersegmental arteries is also occasionally documented during spinal angiography. All these inferior phrenic artery variants can be viewed as the selection of alternative connection patterns within the primitive periaortic network of Jeidell.

Clinical implications

Most studies looking at the vascular anatomy of the right colon are related to colic cancer and its surgical treatment. Standard therapy includes complete resection of the tumor, with ligation of its vessels and dissection of the lymphatic drainage area (Herfarth and Runkel, 1994). As locoregional metastatic spread tends to follow arterial paths, the surgical planning will vary according to the anatomy of the supplying arteries. An accurate understanding of their origins and courses is therefore essential to optimal management (Yada et al., 1997; Shatari et al., 2003), and preoperative radiological mapping of the vascular anatomy, CT (computed tomography) angiography in particular, plays a critical role in this evaluation (Smith et al., 2006; Tajima, et al., 2011; Mari et al., 2013). Failing to recognize atypical arterial patterns such as the one presented here may lead to intraoperative surprises and suboptimal surgical treatment. Aberrant vessels may also be injured during abdominal aortic aneurysm repair, either with open or endovascular techniques, potentially resulting in colic ischemia (Perry et al., 2008). Finally, the possibility of a branch with an aberrant origin should also be considered during angiography performed to locate the source of an elusive gastrointestinal bleed.

On the other hand, the presence of an anomalous RCA stemming directly from the aorta may represent an additional source of collateral supply in case of obstruction of the superior or inferior mesenteric arteries, and have a protecting effect against colic ischemic disease. It is also possible that an isolated RCA may become prominent while being recruited as a collateral pathway (Kim et al., 2011). While the other gastrointestinal arteries were not investigated in our patient, as they were not relevant to his medical condition, the absence of significant aortic atheromatous disease and digestive symptomatology renders this hypothesis unlikely in the reported case.

In summary, an isolated RCA emerging directly from the aorta appears to be an exceptional anatomical variation, which sheds some light on the development of the gastrointestinal vascular system, notably the role played by the capillary plexus of Jeidell. This variant can also represents a significant pitfall during abdominal surgical or endovascular procedures.

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