CASE REPORT

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The inferior mesenteric artery arising as a persistence of the ventral longitudinal anastomosis: A rare anatomical variation

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SUMMARY

Routine dissection of an 82-year-old cadaver demonstrated the inferior mesenteric artery arising from two roots: one from the coeliac trunk, and the other from the superior mesenteric artery. There was no discrete connection between the inferior mesenteric artery and the aorta. This variant artery gave off its characteristic branches, including left colic and sigmoidal branches.

This can be explained as an abnormal persistence of the ventral longitudinal anastomotic channel. Furthermore, an understanding of the breadth of variations of mesenteric vasculature is essential to surgeons and proceduralists of the gastrointestinal tract, and may have implications in cancer, retroperitoneal and endovascular surgery.

Key words: Mesenteric vasculature – Inferior mesenteric artery – Variations

INTRODUCTION

The inferior mesenteric artery (IMA) is one of three unpaired visceral arteries arising from the abdominal aorta, together with the coeliac trunk (CT) and superior mesenteric artery (SMA). Variations in the origins of the CT and SMA are common, as they arise in close proximity to each other at the twelfth thoracic and first lumbar vertebral levels respectively. A common origin of these two vessels, the so-called coeliacomesenteric trunk (CMT) has a reported incidence of 1-2% (Sahni et al., 2016), and has been described extensively in the literature (Cavdar et al., 1997; Sridhar Varma et al., 2009; Nelson, 1988). This variation has been explained by Tandler (1904) as an abnormal persistence of the embryonic ventral longitudinal anastomosis – a primitive arterial connection between all three splanchnic vessels that runs parallel and ventral to the dorsal aorta.

In contrast, the origin of the IMA, usually emerging at the level of the third lumbar vertebra, is far more caudal, and is therefore subject to significantly less variation. The absence of the IMA, a term used to describe a variation where the IMA arises from an artery other than the aorta, has been very rarely reported in the literature. Lippert and Pabst (1985) have reported the incidence to be less than 0.1%, however it is unclear how they have defined the variation. The large cadaveric series of Michels (1956), Michels et al. (1965) in 400 dissections and Zebrowski et al. (1971) in 115 dissections failed to report any variations in IMA origin. Similarly, the large radiological study of 142 living patients by Kahn and Abrahms (1964) reported no variations in living patients. To our understanding, the absence of the IMA has been reported in only ten separate case reports (Adachi and Hasebe, 1928; Mori, 1960; Gwyn and Skilton, 1966; Kitamura et al., 1987; Yamasaki et al., 1990; Nonent et al., 2001; Osawa et al., 2004; Yi et al., 2008; Yoo et al., 2011). In nine of these, the IMA was found to arise from the SMA, at the level of L1, forming a so-called bimesenteric trunk. The final case by Nonent et al. (2001) describes all three ventral splanchnic arteries arising together as a coeliaco-bimesenteric trunk. Other variations

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in inter-mesenteric anastomosis have been reported, including the marginal artery of Drummond (1913), the middle mesenteric artery – an anomalous branch from the aorta which replaces the right and middle colic arteries (Siereocinski, 1976; Pillet, 1993), and the Arc of Riolan, also known as the meandering mesenteric artery, or inter-mesenteric arcade (Cabanie and Soutoul, 1954), which is a connection between the middle colic and left colic arteries, present in approximately 60% of cases (Steward and Rankin, 1933).

This case report describes the IMA arising as a persistence of the ventral longitudinal anastomosis with a connection to both the CT and the SMA. To our knowledge, this is the first case report that describes the IMA having separate, discrete connections to both the other splanchnic vessels. Because of this unique feature, the embryological anatomy of Tandler's ventral longitudinal anastomosis may be further elucidated.

MATERIALS AND METHODS

Routine abdominal dissection of an 82-year-old male Caucasian cadaver was performed as per a recognized and widely used dissection manual (Romanes, 2017). According to the associated documentation, this cadaver had no significant abdominal surgery or endovascular procedures during life, and the cause of death was reported as acute myocardial infarction.

Unfortunately, much of the bowel had been removed prior to the discovery of the variant artery. The artery was dissected from the mesentery and its branches supplying the gastrointestinal tract were examined. Structures surrounding the vessel including veins, lymph nodes and nerve plexuses were removed to aid identification.

RESULTS

In this cadaver, the classic arrangement of the mesenteric arteries was absent. The IMA was found to arise from two separate, discrete roots: one arising from the CT (coeliac root) and the other arising from the SMA (superior mesenteric root), as shown in Fig. 1 (see also the schema in Fig. 2). The CT and the SMA showed otherwise normal anatomy, arising from the abdominal aorta at T12 and L1 vertebral levels respectively, approximately 15.2 cm and 14 cm above the aortic bifurcation.

The coeliac root of the IMA arose as the second of four branches from the CT, after the left gastric artery but before the splenic artery. This root had a caliber of 4.8 mm, and proceeded caudally for 7.1 cm, where it then received the superior mesenteric root to form the IMA-proper. This second root emerged as the third branch of the SMA at a distance of 7.8 cm from the origin of the latter artery, after the emergence of the inferior pancreaticoduodenal and middle colic arteries, but before the jejunal arteries. Proceeding caudally, the IMA was noted to cross the gonadal vessels, ureter and left common iliac artery, eventually passing to the left of the rectum. During the artery's course, it gave off the expected branches, namely the left colic artery and the sigmoidal arteries, before continuing across the pelvic brim as the superior rectal artery. The length of the variant IMA from its origin at the CT to its termination as the superior rectal artery was 25.6 cm.

DISCUSSION

To the best of our knowledge, this report marks only the eleventh documented case of the absence of the IMA in the literature. It is unique to the other cases because the IMA was found to arise from two separate, discrete roots: one from the SMA and the other from the CT. Absence of the IMA was first described by Fleishman in 1815, as quoted by Adachi (Adachi and Hasebe, 1928), in a cadaveric dissection of a child. Subsequent to this, it was reported by Adachi over a century later in one case through a dissection series of over 1000 cadavers. Since this time, the variation has been described in total only ten times, most recently by Yi et al. (2008) and then by Yoo et al. (2011). In nine of these cases, the IMA was found to arise directly

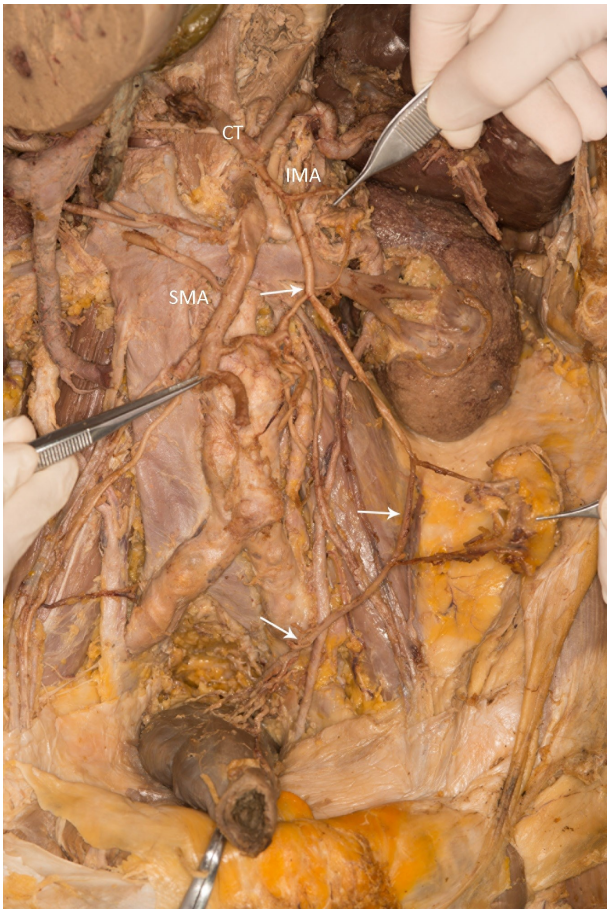

Fig 1. The course and branching of the Inferior Mesenteric Artery (IMA). Superior arrow- confluence of coeliac root and superior mesenteric root of IMA. Middle arrow- left colic branches. Inferior arrow- sigmoidal branches. CT- coeliac trunk. SMA- superior mesenteric artery.

as a branch from the SMA. In all aspects except this, the SMA was found to retain normal anatomy, location and branching. Hence, a more appropriate term for this variation is “the IMA as a branch of the SMA”, rather than the confusing terms of “the absence of the IMA” or “bimesenteric trunk”, which suggest either a failure of the IMA or abnormal SMA anatomy respectively. The only variation from this description has been documented by Nonent et al. (2001), who described a case where all three splanchnic arteries emerged as a single “coeliaco-bimesenteric trunk”.

The case presented here is unique because there is a persistent connection of the IMA to both the CT and the SMA. In our report, the coeliac root of the IMA arose as the second branch of the CT. To our knowledge, there has been no previous documentation of such an association, with only the aforementioned coeliaco-bimesenteric trunk being any documented connection whatsoever between the CT and IMA. In our case, the superior mesenteric root arose after the emergence of the middle colic artery. Origin of the IMA so distal in the course of the SMA has not been previously recorded. In nine of the ten cases, the IMA arose as the second branch of the SMA, after the inferior pancreaticoduodenal artery but before the middle colic artery. Only in one case reported by Gwyn and Skilton (1966) did the IMA arise after the middle colic artery, yet this was only 3.5 cm distal to the origin of the SMA.

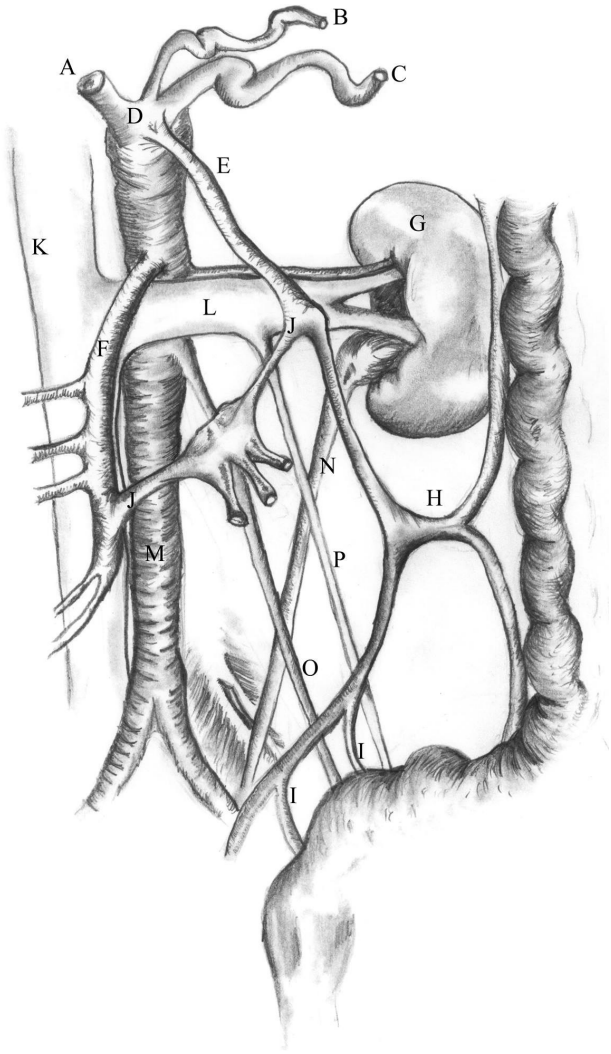

Fig 2. Diagram of the course variant of the inferior mesenteric artery. A- common hepatic trunk, B- left gastric artery, C- splenic artery, D- coeliac trunk, E- coeliac root of the IMA, F- superior mesenteric artery, G- left kidney, H- left colic artery, I- sigmoidal branches, J- superior mesenteric root of the IMA, K- inferior vena cava, L- left renal vein, M- abdominal aorta, N- left ureter, O- left gonadal artery, P- left gonadal vein.

Variations in the origin of the three splanchnic vessels are due to abnormal development of embryological vasculature. The yolk sac is supplied segmentally by seven ventrally directed splanchnic arteries arising from the dorsal aorta (Chevallier, 1998). These vessels are connected to each other by a longitudinal anastomotic channel which lies ventral to the aorta. The normal splanchnic arterial anatomy is formed from a simplification and disappearance of significant numbers of interconnecting segments of the channel, thereby forming three trunks at the aorta (CT, SMA and IMA), which subsequently divide into the original segmental branches. The first three segments combine to originate as the coeliac trunk, the fourth segment originates as the SMA, and the seventh segment originates as the IMA.

Tandler (1904) and then later Morita (1935) discovered that variations in the origin of the CT and SMA may be due to abnormal persistence of the ventral longitudinal anastomosis. If the ventral anastomosis between the CT and SMA persists, and the origin of the SMA at the aorta degenerates, a single trunk will give rise to both the CT and SMA. Tandler’s theory was extrapolated by Kitamura et al. (1987) to explain how the IMA could arise from the SMA. The ventral longitudinal anastomosis may persist between the SMA segment (4^{th}) and the IMA segment (7^{th}). Subsequently, the root of the IMA connecting to the aorta degenerates, meaning that the IMA arises entirely as a persistence of the longitudinal channel, and thus appears to be a branch of the SMA. In our case, there is a connection with both the coeliac trunk and the SMA. This is most likely due to the ventral longitudinal channel persisting between the CT and the SMA, and then the IMA continuing on from this as a branch from the SMA as previously described. This represents the longest persistence of the longitudinal anastomosis that is yet to be reported, and elucidates its importance in embryological development.

Clinically, understanding variations in mesenteric vascular anatomy is essential to proceduralists of the gastro-intestinal tract. In this patient, the IMA is supplied entirely through the CT and SMA, hence any occlusive disease of these vessels would involve bowel in the IMA distribution that would otherwise be unaffected. Furthermore, such variations would have significant implication in cancer surgery, where malignant lymphatic spread travels

along the course of the arterial system.

In summary, we report the eleventh case of the absence of the IMA. Our case is unique because the IMA arose as two discrete roots: one from the CT and the other from the SMA. This can be explained as the longest-reported persistence of the ventral longitudinal anastomosis. Such a variation has significant implications for proceduralists of the gastro-intestinal tract.

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AUTHOR'S CONTRIBUTIONS

All authors were involved in the dissection process to produce photographs worthy of publication. AD and RD contributed significantly to background research as well manuscript preparation. SG and BA contributed significantly through manuscript preparation, editing and production of images and diagrams.

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