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Abstract

Some rare anomalies of the celiaco-mesenteric system were observed postmortem in a Japanese adult male: a) The left gastric, common hepatic, splenic and superior mesenteric arteries arose independently from the abdominal aorta. b) The anterior inferior pancreaticoduodenal artery of the superior mesenteric artery issued a hepatic artery which ascended along the anterior surface of the pancreas and gave off the right gastroepiploic, right gastric and cystic arteries. c) The common hepatic artery gave off an anastomosing branch to the superior mesenteric artery. d) The left gastric artery gave off the left accessory hepatic artery. e) The splenic artery issued the accessory middle colic artery. f) The left inferior phrenic artery gave off the esophageal branch. These anomalies are discussed in light of a typological system which we proposed in a previous paper for the celiaco-mesenteric system.

KEYWORDS: arterial anomaly, celiac trunk, left gastric artery, hepatic artery, splenic artery, intermesenteric anastomosis

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Coexistence of Rare Arteries in the Human Celiaco-Mesenteric System

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Some rare anomalies of the celiaco-mesenteric system were observed postmortem in a Japanese adult male: a) The left gastric, common hepatic, splenic and superior mesenteric arteries arose independently from the abdominal aorta. b) The anterior inferior pancreaticoduodenal artery of the superior mesenteric artery issued a hepatic artery which ascended along the anterior surface of the pancreas and gave off the right gastroepiploic, right gastric and cystic arteries. c) The common hepatic artery gave off an anastomosing branch to the superior mesenteric artery. d) The left gastric artery gave off the left accessory hepatic artery. e) The splenic artery issued the accessory middle colic artery. f) The left inferior phrenic artery gave off the esophageal branch. These anomalies are discussed in light of a typological system which we proposed in a previous paper for the celiaco-mesenteric system.

Key words: arterial anomaly, celiac trunk, left gastric artery, hepatic artery, splenic artery, intermesenteric anastomosis

In previous papers, we reported on two rare anomalies of the human celiaco-mesenteric system, one involving the anterior inferior pancreaticoduodenal artery supplying the liver (1) and another involving the left gastric, splenic, common hepatic and superior mesenteric arteries with separated origins (2). Recently, we encountered the coexistence of these two anomalies. The details of this case are described herein, and the implications for vascular compensation in the mesenteries are discussed.

Materials and Methods

The anomalies were found in a 73-year-old Japanese male who died in 1997 of heart failure. He was fixed conventionally by arterial perfusion with 10 % formalin, and subsequently dehydrated with 50 % ethanol. Dissection was performed in a 1997 human clinical anatomy course for medical students at Okayama University Medical School. He had no history of abdominal surgical procedures.

Results

Gross abdominal anatomy. The liver, pancreas, spleen, stomach, duodenum, kidneys, adrenal glands, diaphragm and other abdominal organs, including the small and large intestines, were normally shaped and positioned. The greater omentum, lesser omentum and other ligaments were also normally related; no marked pathological adhesions of these ligaments and membranes were noted.

Vessels were exposed by mechanical manipulation with pincettes. Positional identification by macroscopic dissection confirmed that the abdominal aorta, inferior vena cava, portal vein and other vessels, including the rectal arteries, presented the usual coursing and branching patterns, except for the anomalies discussed below and diagramed in Fig. 1.

The anomalies are not shown photographically because they were broken in the process of dissection.

Anomalies. The celiac trunk was not present. Thus, the left gastric, common hepatic, splenic and superior mesenteric arteries arose independently from the abdominal aorta.

The left gastric artery gave off the unusual left accessory hepatic artery which ran into the lesser omentum and supplied the liver.

The common hepatic artery issued near its origin a rare branch which descended along the dorsal surface of

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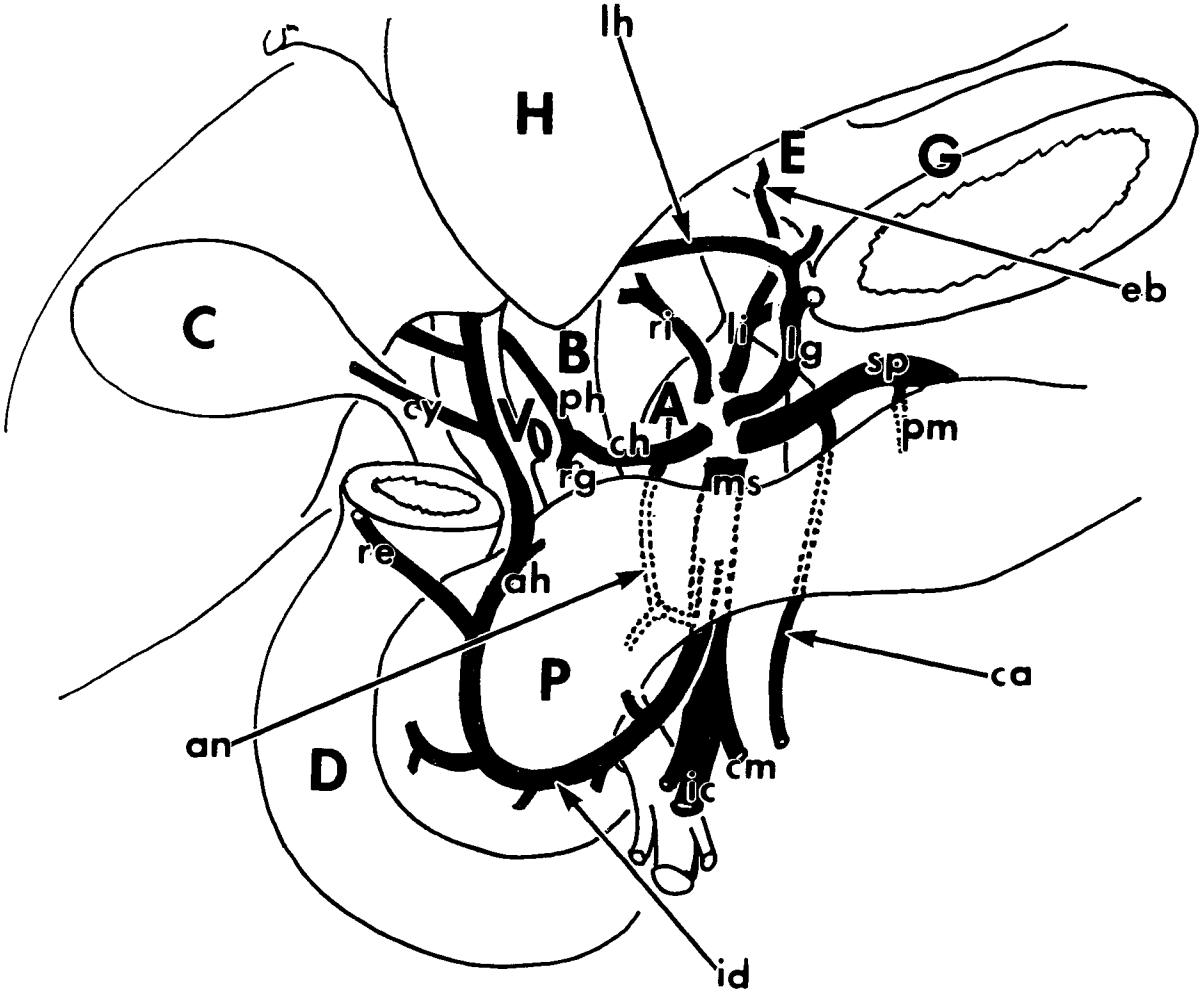

Fig. 1 Schematic representation of the anatomy, demonstrating (1) the unusual left gastric (lg), common hepatic (ch) and splenic (sp) arteries with separated origins, (2) the unusual antero-inferior pancreatico-duodenal artery (id) with the hepatic artery (ah), (3) the unusual anastomosis (an) between the common hepatic (ch) and superior mesenteric (ms) arteries, (4) the rare left hepatic artery (lh), (5) the aberrant accessory middle colic artery (ca) arising from the splenic artery (sp), and (6) the rare esophageal branch (eb) of the left inferior phrenic artery (li).

(Organs) C: Gall bladder; D: Duodenum; E: Esophagus; G: Stomach; H: Liver; L: Intestine; M: Cloaca; O: Allantois; P: Pancreas; T: Hindgut; V: Portal vein.

(Celiaco-mesenteric arteries) 1: Left and right subphrenic arteries; 2: Left and right upper ventricular arteries; 3: Left and right middle ventricular arteries; 4: Left and right lower ventricular arteries; 5: Left and right upper intestinal arteries; 6: Left and right lower intestinal arteries.

ah: Hepatic artery; an: Anastomosis between the common hepatic and superior mesenteric arteries; ca: Accessory middle colic artery; ch: Common hepatic artery; cm: Middle colic artery; cy: Cystic artery; eb: Esophageal branch; ic: Iliocolic artery; id: Inferior pancreaticoduodenal artery; le: Left gastroepiploic artery; lg: Left gastric artery; lh: Left accessory hepatic artery; li: Left inferior phrenic artery; mi: Inferior mesenteric artery; ms: Superior mesenteric artery; ph: Proper hepatic artery; pm: Pancreatic branch (arteria pancreatica magna); re: Right gastroepiploic artery; rg: Right gastric artery; rh: Right accessory hepatic artery; ri: Right inferior phrenic artery; sd: Superior pancreaticoduodenal artery; sp: Splenic artery; tc: Celiac trunk.

(Other arteries) A: Abdominal aorta; c: Intercostal or lumbar arteries; k: Left renal artery; l: Common iliac arteries; m: Left middle adrenal artery; p: Inner iliac arteries; t: Left testicular or ovarian artery; u: Umbilical or supravesical arteries; v: Vitelline arteries.

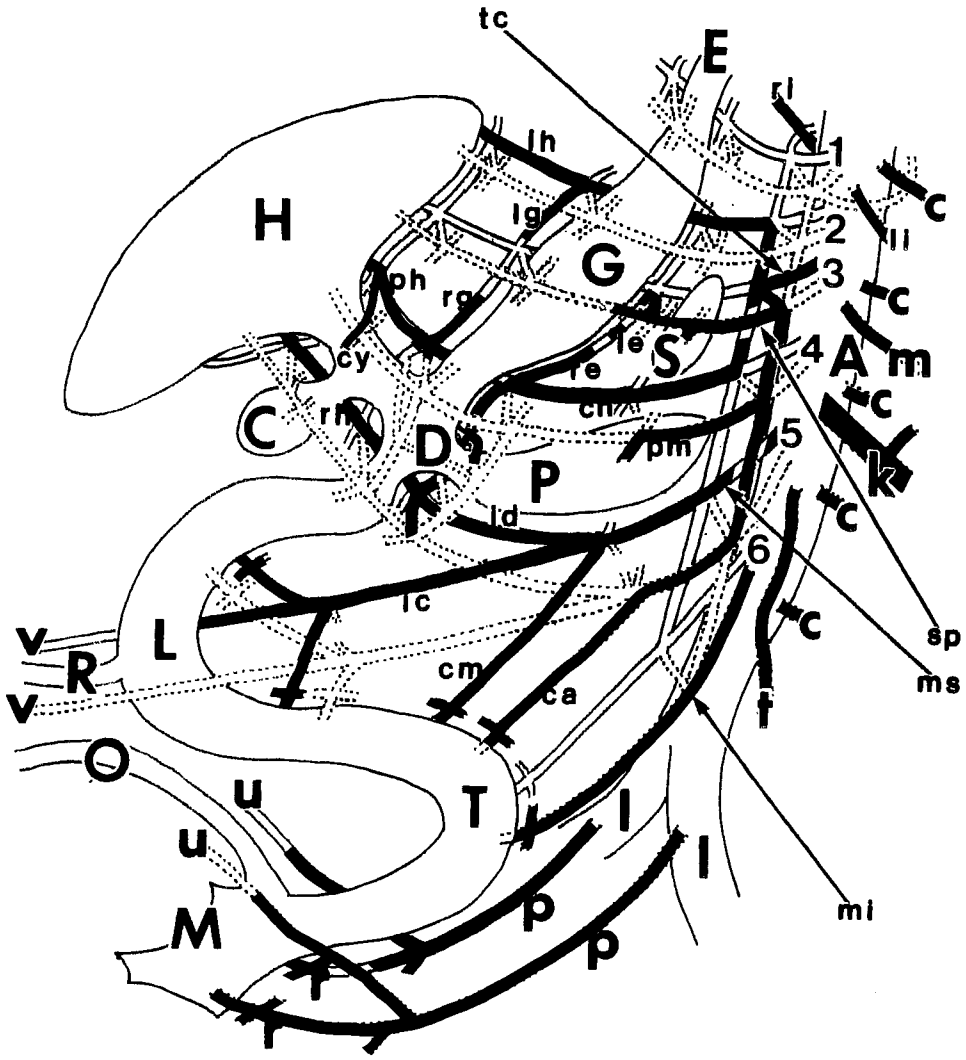

Fig. 2 An ideal or typological pattern of the celiaco-mesenteric arteries at an early stage of fetal period (viewed from the left side), modified from Murakami *et al.* (10). The left sided-vessels and anastomsing vessels are shown by dotted lines, and the right-sided vessels by solid lines. The stomach (G), duodenum (D), intestinal loop (L) and their associated organs are supplied by the six sets of paired vessels: left and right subphrenic arteries (1), left and right upper ventricular arteries (2), left and right middle ventricular arteries (3), left and right lower ventricular arteries (4), left and right upper intestinal (superior mesenteric) arteries (5), and left and right lower intestinal (inferior mesenteric) arteries (6). Usually, the vessels indicated in red remain, the others being retarded. Strictly speaking, the right upper ventricular, left middle ventricular, right lower ventricular, right upper intestinal and left lower intestinal arteries remain as the left gastric (lg), splenic (sp), common hepatic (ch), superior mesenteric (ms) and inferior mesenteric (mi) arteries, respectively. The lower end of the hindgut is supplied by the rectal branches (r) of the left and right inner iliac arteries (p). Abbreviations: See legend to Fig. 1.

the pancreas and anastomosed into a branch (posterior inferior pancreaticoduodenal artery, see below) of the superior mesenteric artery. The duodenal and pancreatic branches (anterior and posterior superior pancreaticoduodenal arteries) of the common hepatic artery were poorly developed.

The anterior inferior pancreaticoduodenal artery of the superior mesenteric artery was extraordinarily well devel-

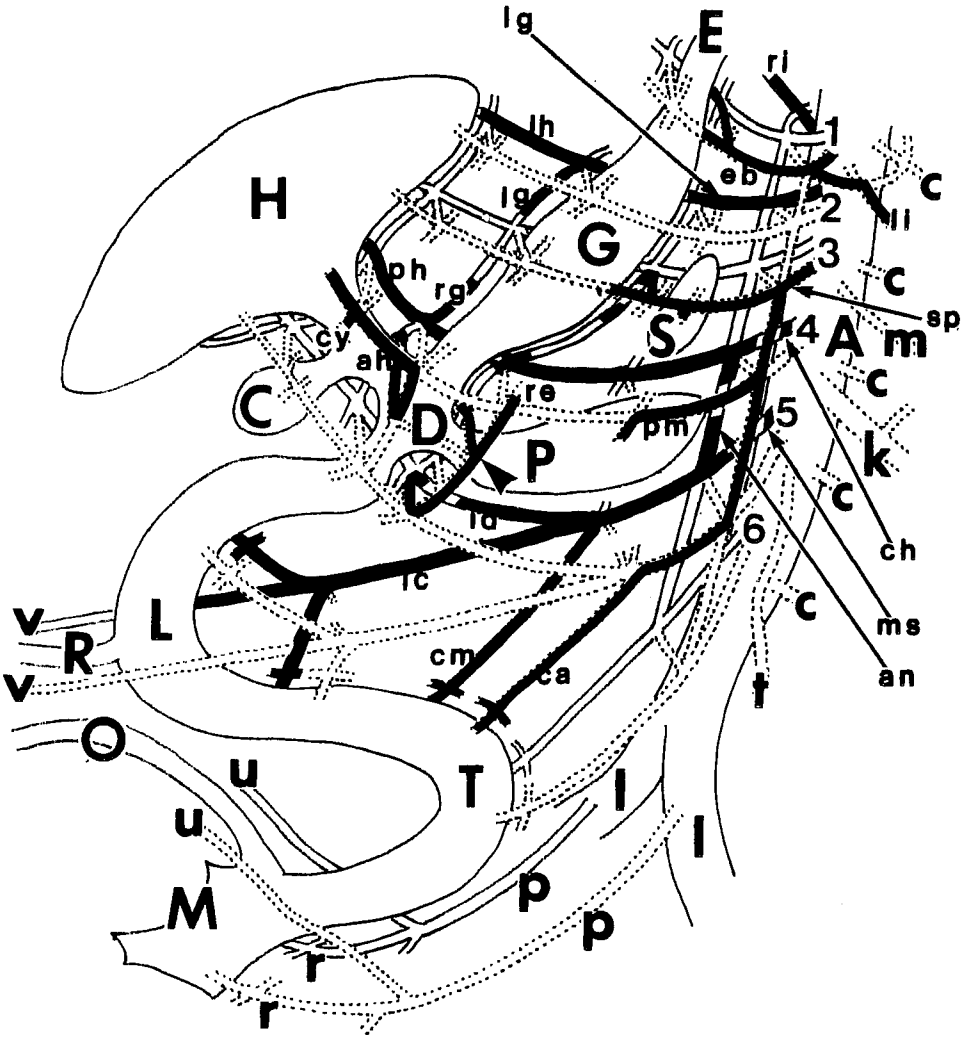

Fig. 3 A typological presentation of the anomalies described in this paper. The vessels indicated in red remain, the others being retarded. Thus, the right upper ventricular, left middle ventricular, right lower ventricular and right upper intestinal arteries remain distinct as the left gastric (lg), splenic (sp), common hepatic (ch) and superior mesenteric (ms) arteries, respectively. The right inferior pancreaticoduodenal artery (id) and left posterior periduodenal longitudinal anastomosis (arrowhead) are fully developed, to issue the accessory common hepatic artery (ah). Abbreviations: See legend to Fig. 1.

oped, and issued a hepatic branch which ascended along the anterior surface of the pancreas and along the anterior aspect of the portal vein. This hepatic branch issued the right gastroepiploic and cystic arteries.

The splenic artery gave off the rare accessory middle colic artery which descended along the dorsal surface of the pancreas and then ran into the transverse mesocolon to supply the transverse colon.

The left inferior phrenic artery gave off a rare esophageal branch which ascended along the esophagus.

Discussion

There are six rare anomalies in the celiaco-mesenteric system of this subject: a) the left gastric, common hepatic and splenic arteries with independent origins, b) the

fully developed anterior inferior pancreaticoduodenal artery which ascends along the anterior surface of the pancreas and gives rise to the hepatic artery and right gastroepiploic artery, c) the anastomosing branch between the common hepatic and superior mesenteric arteries, d) the left accessory hepatic artery, e) the accessory middle colic artery and f) the esophageal branch from the inferior phrenic artery. The individual occurrence of these anomalies has been reported by some authors. These include: independently originated left gastric, common hepatic, splenic and superior mesenteric arteries (2-6); an anterior inferior pancreaticoduodenal artery with hepatic and right gastroepiploic arteries (1); an anastomosis between the common hepatic and superior mesenteric arteries (7-10); a left accessory hepatic artery (7); an accessory middle colic artery (7, 10); and an esophageal branch of the inferior phrenic artery (11).

The celiaco-mesenteric system has been studied by many authors since this system has shown wide variations in its origins and distributions (7, 12-17). However, few authors have discussed the basic pattern of this system. Tandler (18) and Felix (19) studied the serial sections of the human fetus, and described how the celiaco-mesenteric system originates in a vascular network. Morita (12) cited the work of Tandler (18), and described that the celiaco-mesenteric system consists of longitudinally anastomosed unpaired vessels, that is, left gastric, splenic, common hepatic, superior mesenteric and inferior mesenteric arteries.

In a recent paper, we proposed a typological pattern (diagram) for the celiaco-mesenteric system based on studies of 944 Japanese cadavers (Fig. 2) (10). Our pattern implies that the celiaco-mesenteric system develops as six sets of paired vessels (left and right subphrenic, left and right upper ventricular, left and right middle ventricular, left and right lower ventricular, left and right upper intestinal, and left and right lower intestinal arteries) which are modified during the later stages of fetal development (by rotation of intestinal loop and successive changes such as the fusion of the dorsal mesentery with the dorsal abdominal wall, the formation of omental bursa and the leftward migration of spleen). As discussed elsewhere and shown in Fig. 2, our pattern is widely useful for explaining the variations (10), including the esophageal branches, of the inferior phrenic arteries (11).

Our pattern is also useful for explaining the anomalies described in this paper (Fig. 3). In this case, the right upper ventricular (left gastric), left middle ventricular (splenic) and right lower ventricular (common hepatic) arteries may be fully developed as thoroughly independent vessels, forming no celiac (common) trunk; and the left longitudinal anastomosis between the distal segments of the left lower ventricular and right upper intestinal arteries may be fully developed by giving off the unusual hepatic artery ascending along the anterior surfaces of the pancreas and portal vein. The longitudinal anastomosis between the proximal segments of the superior and inferior mesenteric arteries may represent a remnant of the right longitudinal anastomosis between the right lower ventricular and right upper intestinal arteries.

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