folia medica

Folia Medica 65(3):500-507
DOI: 10.3897/folmed.65.e72710

Case Report

Absent Celiac Trunk and Unusual Arterial Anatomy of the Upper Abdomen: into the Deep

Serghei Covantsev[1,3], Rasul Uzdenov[2], Natalia Mazuruc[1], Daria Turovets[3], Olga Belic[1]

[1] *Department of Human Anatomy, Nicolae Testemitanu State University of Medicine and Pharmacy, Chisinau, Moldova*

[2] *Department of Hospital Surgery with the Course of Anesthesiology and Intensive Care, North Caucasian State Academy, Stavropol, Russia*

[3] *Botkin Hospital, Moscow, Russia*

Corresponding author: Serghei Covantsev, Department of Human Anatomy, Nicolae Testemitanu State University of Medicine and Pharmacy, Chisinau, Moldova; Email: kovantsev.s.d@gmail.com

Received: 7 Aug 2021 ♦ **Accepted:** 8 Oct 2021 ♦ **Published:** 30 June 2023

Citation: Covantsev S, Uzdenov R, Mazuruc N, Turovets D, Belic O. Absent celiac trunk and unusual arterial anatomy of the upper abdomen: into the deep. Folia Med (Plovdiv) 2023;65(3):500-507. doi: 10.3897/folmed.65.e72710.

Abstract

The celiac trunk is the first major branch of the abdominal aorta. It originates from the ventral aspect of the aorta at the level of T12–L1 vertebrae and was originally described as an artery that branches into the common hepatic artery, left gastric artery, and splenic artery. Absence of the celiac trunk and origin of the three arteries separately from the aorta is a rare entity that is reported in 0.38% to 2.6% of cases. It is even more uncommon that this variation can be accompanied by other vascular variations of the upper abdomen as accessory arteries to the liver, stomach, and pancreas. These cases arise during embryogenesis due to decreased arterial degeneration combined with decreased arterial fusion, which results in the anatomical variations present in the current case. Complex arterial variations are both a risk for iatrogenic injury during surgical procedures and beneficial during endovascular supply as they may provide additional access for embolization and chemotherapy.

Keywords

accessory left gastric artery, accessory right hepatic artery, celiac trunk, hepatomesenteric trunk.

INTRODUCTION

The celiac trunk is the first major branch of the abdominal aorta. It originates from the ventral aspect of the aorta at the level of T12–L1 vertebrae and was originally described as an artery that branches into the common hepatic artery, left gastric artery, and splenic artery.[1] These branches make the celiac trunk the center of arterial supply of the upper abdomen and an important anatomical structure during invasive and mini-invasive procedures. It is important to consider developmental variations of the celiac trunk during various invasive and therapeutic procedures such as surgery of the organs of upper abdomen, endovascular procedures, etc.[2] Due to the anatomical variations, there have been multiple attempts to classify the anatomy of celiac trunk by Lipshutz (1917), Adachi (1928), Morita (1935) and others.[3-5] Not all variations have been observed until now and the existence of diverse classifications makes the topic more complicated for both clinical practice and research.[1,2]

We present an anatomical case report of an absent celiac trunk with the coexistence of various developmental variations of the arterial supply of the upper abdomen.

CASE REPORT

During dissection of the internal organs of the upper part of the abdominal cavity of a 56-year-old man, we encountered multiple variations of the arterial supply. The celiac trunk was absent and all three vessels began as separate branches from the abdominal aorta. The splenic artery had a diameter

of 0.7 cm and originated from the abdominal aorta 1.7 cm below the inferior phrenic artery. A common trunk (0.5 cm in length) that branched into the left gastric artery and superior adrenal artery was located at the same level on the left. The left gastric artery supplied the lesser curvature of the stomach, and the right superior adrenal artery gave off seven short branches to the upper pole of the adrenal gland, as well as a branch to the diaphragm. The common hepatic artery branched and the superior mesenteric artery had a common trunk extending from the aorta 1.8 cm below the splenic artery ***(Fig. 1)****.*

At a distance of 2.3 cm from the origin of the common hepatic artery, the inferior pancreatic artery branched off, supplying blood to the anterior surface of the pancreatic head. The common hepatic artery continued into the proper hepatic artery, giving off the gastroduodenal artery at the level of the lower edge of the liver, to the right of the caudate lobe, in the region of the neck of the pancreas ***(Fig. 1)****.*

The proper hepatic artery traveled over the portal vein of the liver and had a length of 2.7 cm. In the region of the distal third, it gave off the right gastric artery, and then branched into the left and right hepatic arteries. The left hepatic artery branched into two branches of the first order, the right one provided blood supply mainly to the left lobe of the liver, the second branch (left), 2.2 cm from its beginning, gave off an accessory left gastric artery, then entered the caudate lobe of the liver. The accessory left gastric artery, bending around the upper edge of the posterior part of the liver, divided into two branches. One of them supplied the stomach and did not anastomose with other branches that formed arcades. The other branch provided blood supply to the sphincter and the lower third of the esophagus. The right hepatic artery provided blood supply to the right side of the liver and gallbladder. The cystic artery branched off in the area of the Calo triangle and divided into the anterior and posterior branches in the area of the gallbladder's neck ***(Fig. 2)****.*

The gastroduodenal artery ran along the upper edge of the pancreatic head. The artery branched into the superior anterior pancreatoduodenal artery and the superior posterior pancreatoduodenal artery. Two right gastroepiploic arteries

Figure 1. **1**: aorta; **2**: splenic artery; **3**: common trunk branching into the left gastric artery and the right superior adrenal artery; **4**: left gastric artery; **5**: superior adrenal artery; **6**: inferior phrenic artery; **7**: superior mesenteric artery; **8**: common hepatic artery; **9**: inferior pancreatic artery; **10**: gastroduodenal artery; **11**: right gastric artery; **12**: right gastroepiploic artery; **13**: accessory right gastroepiploic artery; **14**: pyloric artery; **15**: superior anterior pancreatoduodenal artery; **16**: head of the pancreas; **17**: portal vein; **18**: body of the pancreas; **19**: greater pancreatic artery; **20**: inferior vena cava; **21**: left renal vein; **22**: left kidney; **23**: spleen; **24**: stomach (turned away; back surface); **25**: liver; **26**: gallbladder.

Folia Medica

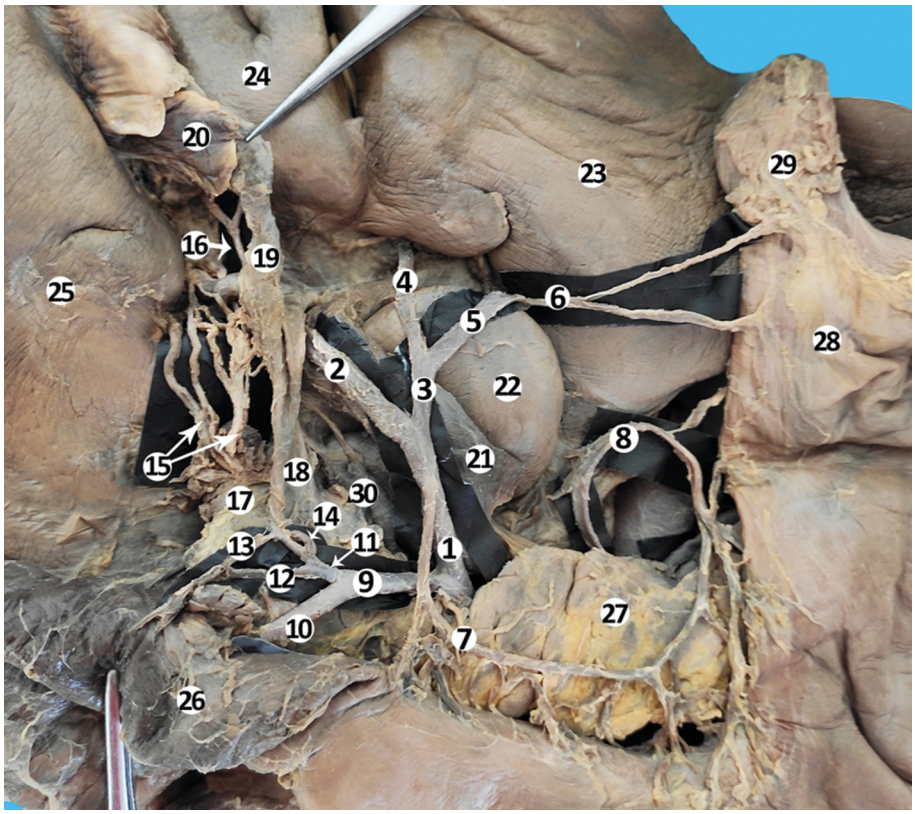

Figure 2. **1**: proper hepatic artery; **2**: right hepatic artery; **3**: left gastric artery; **4**: right branch of the first order of the left hepatic artery; **5**: left branch of the first order of the left hepatic artery; **6**: accessory left gastric artery; **7**: right gastric artery; **8**: left gastric artery; **9**: gastroduodenal artery; **10**: superior anterior pancreatoduodenal artery; **11**: superior posterior pancreatoduodenal artery; **12**: the first branch of the superior posterior pancreatoduodenal artery; **13**: second branch of the superior posterior pancreatoduodenal artery; **14**: the third branch of the superior posterior pancreatoduodenal artery; **15**: branches to the right lobe of the liver; **16**: cystic artery; **17**: head of the pancreas; **18**: common bile duct; **19**: cystic duct; **20**: gallbladder; **21**: portal vein; **22**: caudate lobe of the liver; **23**: the left lobe of the liver; **24**: the quadrate lobe of the liver; **25**: the right lobe of the liver; **26**: the duodenum; **27**: body of the pancreas; **28**: stomach; **29**: esophagus.

and a pyloric artery originated from the superior pancreatoduodenal artery. The right gastroepiploic arteries passed along the greater curvature of the stomach, anastomosing with each other, as well as with the branches of the left gastroepiploic artery extending from one of the branches of the splenic artery. The superior posterior pancreatoduodenal artery, located along the upper edge of the head of the pancreas, immediately branched into three small arteries. The first branch supplied the duodenum. The second bended around the head of the pancreas along its right edge and then entered the posterior surface of the gland. The third branch entered the parenchyma of the gland, traveled 1.7 cm within the gland and then exited from the pancreas dividing into three short thin branches. These three branches entered the parenchyma of the right lobe behind the common bile duct, together with the right hepatic artery. The most medial of them supplied the common bile duct with several small branches ***(Fig. 2)****.*

The splenic artery had a fairly straight trajectory with one convoluted section, after which it branched into a large pancreatic artery. It, in turn, branched into the left branch, which supplied blood to the body of the pancreas, and the right branch, which gave off branches mainly to the tail of the pancreas. At the level of the distal third, the artery split into two first-order branches, the superior splenic artery of the first order branched into two second-order arteries. Two upper pole arteries branched off from the upper artery of the second order, as well as two short gastric arteries that supplied the posterior surface of the gastric cardia. The left gastroepiploic artery originated at the branching point of the superior splenic artery of the first order and passed along the greater curvature of the stomach, participating in the blood supply to the posterior wall of the stomach and the greater omentum. At a distance of 2.3 cm from its beginning, this artery gave off the second short gastric artery, which also took part in the blood supply to the fundus of the stomach.

The lower splenic artery of the first order gave off two branches of the second order directed to the splenic parenchyma in the area of the hilum ***(Fig. 3)****.*

The superior mesenteric artery branched off from the common hepatomesenteric trunk and descended at a 90° angle, maintaining a straight trajectory. The diameter of the trunk was 2.5 mm in the largest segment. From the left semicircle of the trunk of the superior mesenteric artery, 12 arteries branched to the loops of the jejunum and ileum: seven arter-

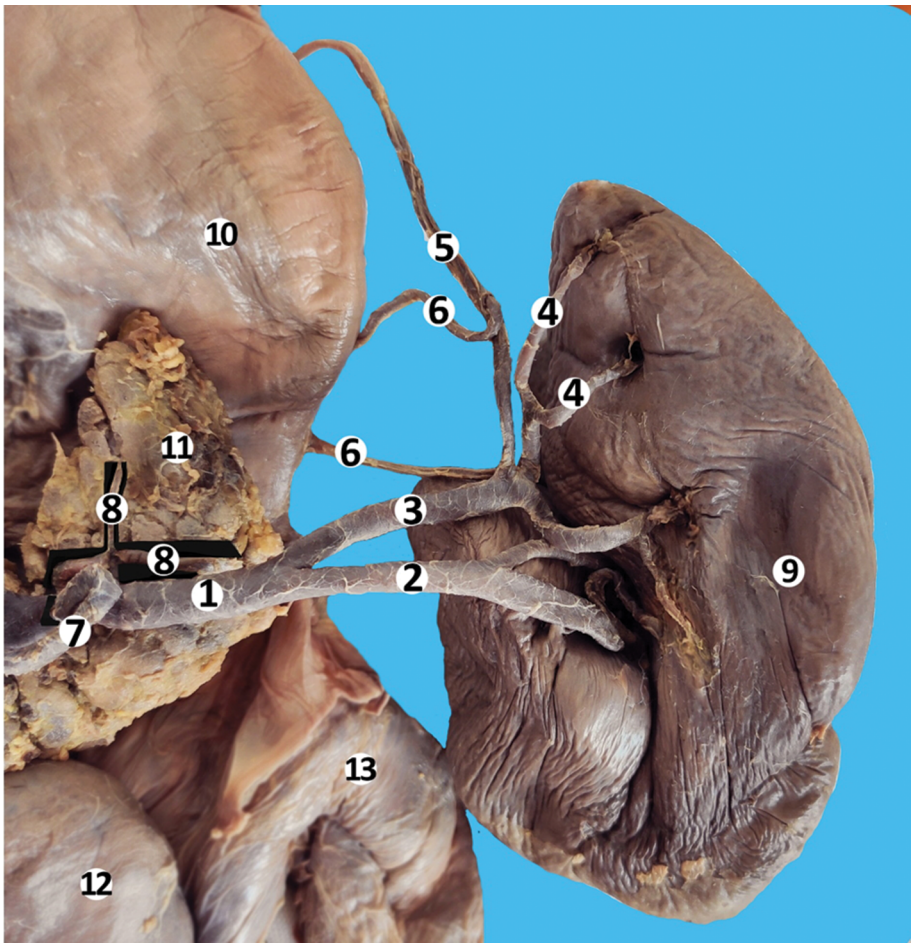

Figure 3. **1**: splenic artery; **2**: lower branch of the splenic artery of the first order; **3**: upper branch of the splenic artery of the first order; **4**: superior polar arteries; **5**: left gastroepiploic artery; **6**: short gastric arteries; **7**: greater pancreatic artery; **8**: branches to the tail of the pancreas; **9**: spleen; **10**: stomach; **11**: pancreatic tail; **12**: left kidney; **13**: diaphragm.

ies to the loops of the jejunum, and five arteries to the ileum. The jejunal and ileal arteries formed multiple arcades on their way to the wall of the small intestine. Three-row arcades approached the loops of the jejunum; two rows of arcades were visible in the mesentery of the ileum. These arcades provided smaller branches to the walls of the small intestine.

The ileocolic artery branched off from the right semicircle of the superior mesenteric artery, and headed towards the distal ileum and cecum. In its course, the artery branched into anterior and posterior branches and gave off an artery for the appendix and the ascending colon.

The right colic artery branched off slightly above the ileocolic artery. It formed an anastomosis with the ascending branch of the ileocolic artery on the left, and with the right branch of the middle colic artery on the right. The middle colic artery branched off from the superior mesenteric artery trunk over the right colic artery. Closer to the intestinal wall, the vessel branched off into the right branch, which anastomosed with the branch of the right colic artery, and the left branch, which participated in the formation of the anastomosis along the colon with the branches of the left colic artery (from the inferior mesenteric artery) ***(Fig. 4)****.*

A schematic representation of all anatomical variations is presented in ***Fig. 5****.*

DISCUSSION

The number of terminal branches of the celiac trunk is important to consider during surgery. Branching of the celiac trunk into three arteries occurs in 43.6%–90.9% of cases. At the same time, true trifurcation is distinguished, when all three vessels originate from one branch point (7.1%–6.9%) and false trifurcation, in which one of the arteries branches earlier. Bifurcation of the vessel is seen in 1.3% to 7.1% of cases. Additional branches are described in 5.2%–47.9% of cases. Most often, these branches are the inferior phrenic arteries (2.77%–41.4%), but they can also be lumbar arteries, arteries of the head or body of the pancreas, liver, stomach, and colon. Usually, there is only one accessory artery (5.2%–12.9%). However, there are cases when the celiac trunk branches into five branches (12.9%), six branches (1.4%), and seven branches (0.7%). Origin of the common hepatic, splenic, and left gastric artery inde-

Folia Medica

Figure 4. Superior mesenteric and its branches. **1**: aorta; **2**: splenic artery; **3**: common trunk that branched into the left gastric artery, the upper right adrenal artery, and a branch to the diaphragm; **4**: left gastric artery; **5**: superior adrenal artery; **6**: inferior phrenic artery; **7**: hepato-mesenteric trunk; **8**: common hepatic artery; **9**: superior mesenteric artery; **10**: right gastric artery; **11**: gastroduodenal artery; **12**: superior anterior pancreatoduodenal artery; **13**: right gastroepiploic artery; **14**: accessory right gastroepiploic artery; **15**: pyloric artery; **16**: inferior pancreatoduodenal artery; **17**: greater pancreatic artery; **18**: portal vein; **19**: inferior vena cava; **20**: left renal vein; **21**: arteries to the small intestine; **22**: iliac artery; **23**: right colic artery; **24**: middle colic artery; **25**: the ascending colon; **26**: superior mesenteric vein; **27**: the descending colon; **28**: the transverse part of the colon; **29**: caecum; **30**: loops of the ileum; **31**: loops of the jejunum; **32**: left kidney; **33**: spleen; **34**: the body of the pancreas; **35**: head of the pancreas; **36**: liver; **37**: gallbladder; **38**: common bile duct; **39**: stomach (inverted, posterior surface); **40**: greater omentum.

pendently from the aorta ranges from 0.38% to 2.6% of cases.[6-8]

The celiac trunk has a central role in the blood supply to the liver, gallbladder, spleen, pancreas, and stomach. According to the latest classification proposed by Marco-Clement and coworkers based on radiological and anatomical studies, celiac trunk branching can be divided into four main types: complete (type I), incomplete (type II), no celiac trunk (type III), and celiacomesenteric trunk (type IV).[9]

The rare types of celiac trunk branching is type III, in which all branches extend directly from the aorta or from its branches. Vandamme et al. reported this type of variation in 1.3% of 156 anatomical specimens.[10] Iezzi et al., in their study on the basis of 524 CT angiograms, found this type in 0.6% of cases.[11]

Variant anatomy of the common hepatic artery occurs in the world population on average in 10%–42% of cases. Single vessel variation is found in 22.89% of cases, and multiple arterial variations in 4.21% of cases.[12] According to the latest data from a study by Faisal Hanif et al. based on 1000 CT angiograms, an accessory left hepatic artery occurs in 1.6%, while an accessory right hepatic artery is found in 0.7%.[13] Presence of three accessory hepatic arteries that originate at the level of the pancreas is a rare case.

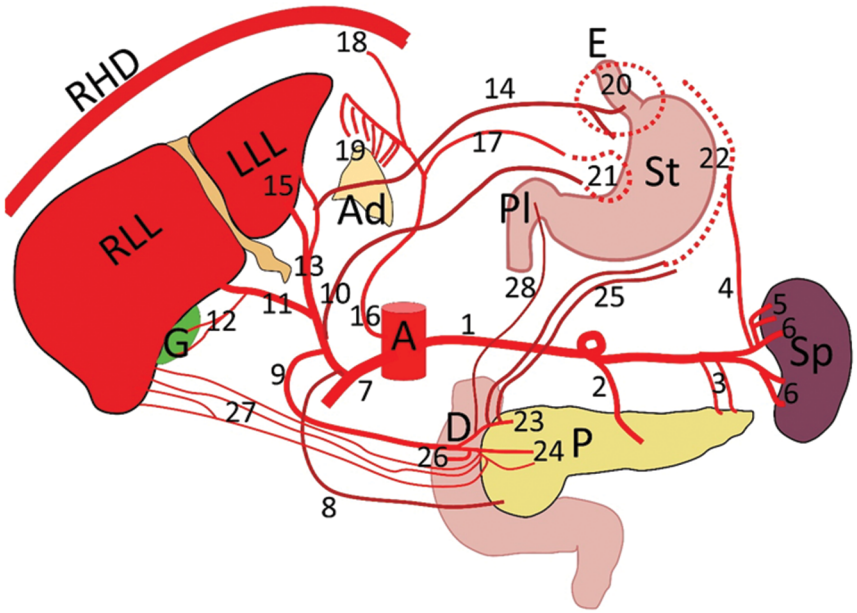

Figure 5. Schematic representation of the arterial supply. **A**: aorta; **St**: stomach; **Pl**: pylorus; **Sp**: spleen; **P**: pancreas; **D**: duodenum; **G**: gallbladder; **RLL**: right liver lobe; **LLL**: left liver lobe; **Ad**: adrenal gland; **RHD**: right hemidiaphragm; **E**: esophagus; **1**: splenic artery; **2**: greater pancreatic artery; **3**: arteries to the pancreatic tail; **4**: left gastro-epiploic artery; **5**: superior polar arteries to the spleen; **6**: terminal branches of the splenic artery; **7**: hepato-mesenteric trunk; **8**: inferior pancreatic artery; **9**: gastroduodenal artery; **10**: left splenic artery; **11**: right hepatic artery; **12**: cystic artery; **13**: left hepatic artery; **14**: accessory left gastric artery; **15**: terminal branches of the left hepatic artery; **16**: common gastro-adreno-phrenic trunk; **17**: accessory left gastric artery; **18**: right phrenic artery; **19**: superior adrenal artery and its branches; **20**: anastomoses at the level of lower esophagus and gastric cardia; **21**: anastomoses at the lesser gastric curvature; **22**: anastomoses at the greater gastric curvature; **23**: superior pancreatic artery; **24**: inferior pancreatic artery; **25**: two right gastro-epiploic arteries; **26**: duodenal artery; **27**: accessory right hepatic arteries; **28**: pyloric artery.

Accessory gastric arteries are relatively frequent in the population and most commonly originate from hepatic vessels (21.2%).[14] The right gastric artery originates more often from the proper hepatic artery (53%), from the bifurcation point of the common hepatic artery (20%), from left hepatic artery (15%), and less commonly, from the gastroduodenal artery (8%) or common hepatic artery (4%). [15] The presence of accessory gastric arteries that originate from a common trunk together with adrenal and phrenic arteries from the aorta as in the current case is a rare entity.

The arterial supply of the pancreas is complex and there are various types of vascular supply of the gland.[16] However, it is uncommon for an artery to travel through the gland without participating in its arterial supply as in the present case.

The inferior phrenic arteries originate from the aorta or celiac trunk and, in rare cases, from the renal arteries. There are reports of various other sites of origin, such as the left gastric, hepatic, superior mesenteric, spermatic, and adrenal arteries.[17,18] The current case is unusual since the right inferior phrenic artery originated from a common trunk together with the right superior adrenal artery and accessory left gastric artery. This is especially important as the right phrenic artery can participate in the vascular supply of the hepatocellular carcinoma, and can be cannulated for embolization.[19]

Arterial anatomy of the abdominal cavity has a complicated embryological development due to organ migration and turn, which is accompanied by growth and degeneration of vascular structures. This is one of the reasons for supernumerary arteries in adults. Another important embryological cause is the unequal growth of walls of aorta that helps to fuse different arterial branches.[20,21] The decreased arterial degeneration combined with decreased arterial fusion results in the anatomical variations presented in the current case.

CONCLUSIONS

Arterial variations of the upper abdomen are relatively frequent, but usually are related to a single organ. Complex arterial variations can both pose a risk during surgical procedures and be beneficial during endovascular supply, as they provide additional access for embolization and chemotherapy.

Acknowledgements

The authors have no support to report.

Funding

The authors have no funding to report.

Competing Interests

The authors have declared that no competing interests exist.

REFERENCES

1. Covantev S, Mazuruc N, Drangoi I, et al. Unusual development of the celiac trunk and its clinical significance. J Vasc Bras 2021; 20:e20200032.
2. Covanțev S, Mazuruc N, Belic O. An unusual case of colon vascularization by the inferior mesenteric artery. J Vasc Bras 2017; 16(1):52–5.
3. Adachi B. Das arteriensystem der Japaner. Band 1928.
4. Lipshutz B. A composite study of the coeliac axis artery. Ann Surg 1917; 65(2):159–69.
5. Morita M. Reports and conception of three anomalous cases of the coeliac and the superior mesenteric arteries. Igaku Kenkyu 1935; 9:1993–2006.
6. Pinal-Garcia DF, Nuno-Guzman CM, Gonzalez-Gonzalez ME, et al. The celiac trunk and its anatomical variations: a cadaveric study. J Clin Med Res 2018; 10(4):321–9.
7. Juszczak A, Mazurek A, Walocha JA, et al. Coeliac trunk and its anatomic variations: a cadaveric study. Folia Morphologica 2021; 80(1):114–21.
8. Venieratos D, Panagouli E, Lolis E, et al. A morphometric study of the celiac trunk and review of the literature. Clin Anat 2013; 26(6):741–50.
9. Marco-Clement I, Martinez-Barco A, Ahumada N, et al. Anatomical variations of the celiac trunk: cadaveric and radiological study. Surg Radiol Anat 2016; 38(4):501–10.
10. Vandamme JP, Bonte J. The branches of the celiac trunk. Acta anatomica 1985; 122(2):110–4.
11. Iezzi R, Cotroneo AR, Giancristofaro D, et al. Multidetector-row CT angiographic imaging of the celiac trunk: anatomy and normal variants. Surg Radiol Anat 2008; 30(4):303–10.
12. Gkaragkounis A, Fanariotis M, Tepetes K, et al. Celiac trunk and hepatic arteries: anatomical variations of liver arterial supply as detected with multidetector computed tomography in 1,520 patients and its clinical importance. Clin Anat 2020; 33(7):1091–101.
13. Hanif F, Farooq U, Malik AA, et al. Hepatic artery variations in a sample of Pakistani population. J Coll Physicians Surg Pak 2020; 30(2):187–91.
14. Ishigami K, Yoshimitsu K, Irie H, et al. Accessory left gastric artery from left hepatic artery shown on MDCT and conventional angiography: correlation with CT hepatic arteriography. Am J Roentgenol 2006; 187(4):1002–9.
15. Eckmann I, Krahn V. Frequency of different sites of origin of the right gastric artery. Anatomischer Anzeiger 1984; 155(1-5):65–70.
16. Covantev S, Mazuruc N, Belic O. The arterial supply of the distal part of the pancreas. Surg Res Pract 2019; 2019:5804047.
17. Gwon DI, Ko G-Y, Yoon H-K, et al. Inferior phrenic artery: anatomy, variations, pathologic conditions, and interventional management. Radio Graphics 2007; 27(3):687–705.
18. Kahn PC. Selective angiography of the inferior phrenic arteries. Radiology 1967; 88(1):1–8.
19. Basile A, Tsetis D, Montineri A, et al. MDCT anatomic assessment of right inferior phrenic artery origin related to potential supply to hepatocellular carcinoma and its embolization. Cardiovasc Intervent Radiol 2008; 31(2):349–58.
20. Arey LB. Developmental anatomy. A textbook and laboratory manual of embryology. 1954; 416–9.
21. Sarkar M, Mukherjee P, Roy H, et al. An unusual branch of celiac trunk feeding suprarenal gland - a case report. J Clin Diagn Res 2014; 8(4):AD03–AD4.

Отсутствие чревного ствола и необычная артериальная анатомия верхней части живота: вглубь

Сергей Кованцев[1,3], Расул Узденов[2], Наталия Мазурук[1], Дарья Туровец[3], Ольга Белик[1]

[1] Кафедра анатомии человека, Государтвенный университет медицины и фармакологии имени Николае Тестемицану, Кишинев, Республика Молдова

[2] Кафедра госпитальной хирургии с курсом анестезиологии и реаниматологии, Северо-Кавказская государственная академия, Ставрополь, Россия

[3] Государственная клиническая больница им. С.П. Боткина, Москва, Россия

Адрес для корреспонденции: Сергей Кованцев, Кафедра анатомии человека, Государтвенный университет медицины и фармакологии имени Николае Тестемицану, Кишинев, Республика Молдова; E-mail: kovantsev.s.d@gmail.com

Дата получения: 7 августа 2021 ♦ **Дата приемки:** 8 октября 2021 ♦ **Дата публикации:** 30 июня 2023

Образец цитирования: Covantsev S, Uzdenov R, Mazuruc N, Turovets D, Belic O. Absent celiac trunk and unusual arterial anatomy of the upper abdomen: into the deep. Folia Med (Plovdiv) 2023;65(3):500-507. doi: 10.3897/folmed.65.e72710.

Резюме

Чревный ствол является первой крупной ветвью брюшной аорты. Она берёт начало от вентральной части аорты на уровне позвонков T12–L1 и первоначально была описана как артерия, которая разветвляется на общую печёночную артерию, левую желудочную артерию и селезёночную артерию. Отсутствие чревного ствола и отхождение трёх артерий отдельно от аорты – редкое состояние, о котором сообщают в 0.38–2.6% случаев. Ещё более редко эта вариация может сопровождаться другими сосудистыми вариациями верхней части живота в виде дополнительных артерий к печени, желудку и поджелудочной железе. Эти случаи возникают во время эмбриогенеза из-за снижения дегенерации артерий в сочетании с уменьшением слияния артерий, что приводит к анатомическим вариациям, присутствующим в данном случае. Сложные артериальные вариации представляют собой риск ятрогенного повреждения во время хирургических процедур и полезны при эндоваскулярном кровоснабжении, поскольку они могут обеспечить дополнительный доступ для эмболизации и химиотерапии.

Ключевые слова

добавочная левая желудочная артерия, добавочная правая печёночная артерия, чревный ствол, печёночно-брыжеечный ствол.