



Anatomical Variations of Coeliac Axis and Common Hepatic Artery- Systematic Analysis of Multi detector Computed Tomography Images

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Abstract

Purpose: *The study was conducted to identify and evaluate the spectrum of anatomical variations of the coeliac axis (CA) and common hepatic artery (CHA) seen in multi detector computed tomography (MDCT) images.*

Materials and Methods: *The pattern of origin, course and branching of coeliac axis and common hepatic artery were evaluated in CT images of patients in Dept of Radiodiagnosis, Government Medical College, Trivandrum. A pre described nomenclature system is used for the systematic description of coeliac axis and common hepatic artery variations. CHA was defined as an arterial trunk containing at least one segmental hepatic artery and the gastroduodenal artery.*

After assessing the coeliac axis anatomy the branching pattern of the downstream hepatic arteries including their origin site, anatomic course specifically of the common hepatic, left and right hepatic arteries and the gastroduodenal artery was studied.

Results: *A total of 149 out of 150 cases had a normal coeliac axis anatomy which appeared as a hepatogastrosplenic trunk and SMA originating separately from the aorta (HSpM+SM). Variant identified was a hepatogastric trunk with splenomesenteric trunk (HG+SpM). 137 patients had a normal CHA anatomy in which the CHA originated from the coeliac axis, and had a suprapancreatic preportal course. In the remaining 13 patients variations in its origin and/or anatomic course were noted.*

Conclusion: *With a clear definition of normal and variant CHA, we were able to perform a systematic analysis of CT images using nomenclature system and summarize the observed variations.*

Keywords: *Coeliac axis, Common hepatic artery, systematic analysis, nomenclature system.*

Introduction

Anatomical variability is noted in the origin of vessels that supply the abdominal organs. A prior knowledge of the extent of variations in vascular anatomy is essential for minimizing serious ischaemic complications in laparoscopic, surgical

and vascular interventional radiological procedures. Within the field of interventional radiology, there is an ever-increasing demand for deeper knowledge of the anatomy of the regional vasculature and its variations.

Materials and Methods

The study was conducted at Department of Radiodiagnosis, Government Medical College, Trivandrum. Approval for the study from the Institutional Research committee and Ethical committee was obtained. The scans of consecutive 100 adult patients who underwent CT scan of abdomen or CT angiogram of abdomen in previous month were taken for the study. Patients with a history of major surgical procedure of abdomen were excluded.

Patients in whom the branches were not well defined on images due to technical reasons - poor patient breath hold causing movement artefacts, or lack of adequate contrast in vessels also were excluded.

CT examination: All studies were done on the multislice (128 slice) CT unit

(Siemens) after adequate patient preparation. First nonenhanced images were obtained from the level of diaphragm in a craniocaudal direction. Then oral contrast (iodinated contrast diluted with water in the ratio 1:20) was given to opacify and distend the bowel lumen. The oral contrast volume varied from patient to patient. Then non ionic iodinated contrast media was injected at the rate of 3-4 ml/sec by hand injection through a 18 or 20 gauge plastic canula into the ante cubital vein. Contrast medium volume varied from 70 to 100 ml (delivered at 1.5 ml per kilogram body weight). Hepatic arterial phase images were taken 20 seconds after completion of contrast administration, 20-30 seconds later portal phase imaging was done. Equilibrium phase images were acquired 180 seconds after completion of the contrast administration.

Image interpretation

Continuous images were obtained with slice thickness of 0.6 mm. The images were analysed at GE AW workstation. Coronal and sagittal reconstruction images were also studied.

The pattern of the aortic origin of the coeliac and superior mesenteric artery was obtained.

After assessing the coeliac axis anatomy, including its origin site, anatomic course and relationship to surrounding structures, the branching patterns and course of the downstream hepatic arteries –specifically, the common hepatic, left and right hepatic arteries and the gastroduodenal artery was studied .

Description

The origin of arteries arising from the aorta are first evaluated.

Then the coeliac axis is described. The name of the arterial trunks or individual arteries arising from the aorta are connected by plus signs in abbreviations.

Normal anatomy refers to hepatogastrosplenic trunk (HSpG). When naming an arterial trunk the term hepato means the CHAs arise from the trunk. Then the type of CHA variation is described. CHA is defined as an arterial trunk containing at least one segmental hepatic artery and the gastroduodenal artery.

To describe the origin site of a variant CHA branches, the name of the origin site abbreviation is simply connected to the name of the vessel from which it arises by a hyphen. When the right hepatic artery arises from the SMA and left hepatic artery arises from the left gastric artery or the gastroduodenal artery arises directly from the SMA, we describe these variations as RH-SM, LH-LG, GD-SM.

The anatomic course is attached to the end of the type of CHA or branch variation with parentheses. When a variant CHA arises from the SMA and passes through the portocaval space, posterior to the portal vein, and superior to the pancreas, it is described as CH-SM (suprapancreatic, retroportal).

Table 1

Abbreviations and their definitions (1)

| Abbreviation | Description and Definition |
|--------------|---|
| Ao | Aorta |
| CA | Coeliac axis |
| CH | Common hepatic artery – an arterial trunk containing at least one segmental hepatic artery and the gastroduodenal artery, regardless of its origin site or anatomic course. |
| CM trunk | Coeliaco mesenteric trunk |
| GD | Gastroduodenal artery |
| GM trunk | Gastromesenteric trunk |
| GSpM trunk | Gastrospleno mesenteric trunk |
| HG trunk | Hepatogastric trunk |
| HGSp trunk | Hepatogastrosplenic trunk, normal coeliac axis |
| HM trunk | Hepatomesenteric trunk |
| HSp trunk | Hepatosplenic trunk |
| HSpM trunk | Hepatospleno mesenteric trunk |
| LG | Left gastric artery |
| LH | Left hepatic artery |
| PH | Proper hepatic artery, which is an arterial trunk before branching into left and right hepatic arteries, regardless of its origin site or anatomic course. |
| RH | Right hepatic artery |
| SM | Superior mesenteric artery |
| SpM trunk | Spleno mesenteric trunk |
| Sp | Splenic artery |

Table 2. Types of coeliac axis anatomy.(1)

1. HGS trunk.
2. HSptrunk+LG+SM
3. HM trunk +GSp trunk
4. CM trunk
5. HSpM trunk +LG
6. HM trunk +LG+Sp
7. HGtrunk+SpM trunk
8. CH+LG+Sp+SM
9. CH +GSpM trunk
10. CH+LG+SpM trunk
11. HG trunk+ Sp+ SM
12. HSp trunk+ GM trunk
13. HGM trunk +Sp
14. CH+ GM trunk+ Sp
15. Ambiguous anatomy

Table 3 - Definition of arterial segments

| Segment | Description |
|-----------------------|--|
| Celiac axis | Hepatogastrosplenic trunk (HGSp). SMA originating separately from the aorta. |
| CHA normal anatomy | CHA originates from the CA and has a Suprapancreatic preportal course, the arterial trunk containing at least one segmental hepatic artery and the gastro duodenal artery regardless of its origin site or its anatomic course |
| Right hepatic artery | the artery supplying the segments of right lobe of liver |
| Left hepatic artery | the artery supplying the segments of left lobe of liver |
| Left gastric artery | seen along the lesser curvature of stomach arising from CA along with CHA and SpA |
| Splenic artery | artery supplying the spleen entering through the splenic hilum and taking its origin from CA along with LG and CHA |
| Gastroduodenal artery | arising from the CHA which originates from CA and seen anterior to first part of duodenum. |
| Ambiguous celiac axis | Congenital absence of CHA or congenital presence of an anastomotic channel connecting the CA and SMA or anastomotic channel connecting the CHA to the CA and the SMA. |

Results

Of the 15 coeliac axis anatomy types, we could identify only 2 types. A total of 149 cases had a normal celiac axis anatomy which appeared as a hepatogastrosplenic trunk and SMA originating separately from the aorta. Variant identified was a hepatogastric trunk with spleno mesenteric trunk.

137 patients had a normal CHA anatomy in which the CHA originated from the coeliac axis, and had a suprapancreatic preportal course. In the remaining 13 patients variations in its origin and /or anatomic course were noted.

137 patients had both normal right and left hepatic artery anatomy, 140 had normal right hepatic artery anatomy and 147 had normal left hepatic artery anatomy’

Variations in either right or left hepatic artery was found in 13 patients, 10 had variant right hepatic artery anatomy while 3 had variant left hepatic artery. Among the 10 with variant right hepatic artery 9 had its origin from superior mesenteric artery while one was seen rising from the aorta.

When the right hepatic artery was seen arising from the aorta, gastroduodenal artery was seen as

a branch of the common hepatic artery which supplied the left lobe. When the left hepatic artery was seen arising from the aorta, gastroduodenal artery was seen as a branch of the common hepatic artery which supplied the right lobe.

All 9 patients in whom right hepatic artery had its origin from superior mesenteric artery, the vessel had a suprapancreatic, retroportal course.



Fig 1 HSpG + SM , RH-SM (suprapancreatic, retroportal)

In this case the CHA arising from the coeliac axis is seen coursing through its normal preportal course before giving off the GA and LH. The RH after taking origin from SM artery is seen taking a suprapancreatic retroportal course.



Fig 2 LH –Ao.

The LH is seen arising as a separate branch from the Aorta. The CA and SM are also seen.



Fig 3 - RH –SM

The RH is seen taking origin from SM.

Discussion

The celiac artery (or the celiac trunk) provides vascular supply to the foregut: it supplies blood to the stomach, the liver, the spleen and the part of the esophagus that reaches into the abdomen. It also supplies the superior (or upper) half of the duodenum and the pancreas.

The superior mesenteric artery is the second of the three major anterior branches of the abdominal aorta. It arises anteriorly from the abdominal aorta at the level of the L1 vertebrae, immediately inferior to the origin of the coeliac trunk.

In describing the branches of coeliac axis, the branching pattern with the highest prevalence has been reported as its division pattern into left gastric, common hepatic and splenic arteries. Among the variations of branching pattern the common hepatic artery is the key component of the variant anatomy. The textbook definition of common hepatic artery is the segment of hepatic artery coursing from the coeliac axis to the point where the gastroduodenal artery branches. But the CHA can have a variant origin other than the coeliac axis and take various anatomic courses.

By tracing back from the organ supplied to its course upto abdominal aorta can be a useful method to delineate the various branching patterns of coeliac axis. The artery supplying the right lobe of liver, right hepatic artery, that supplying left lobe is the left hepatic artery, that supplying spleen is the splenic artery.

Left gastric artery is the vessel which is seen along the lesser curvature and which flows from

left to right to anastomose with the right gastric artery, a branch of hepatic artery and that which flows from right to left. The left gastric artery gives off an oesophageal branch to the distal oesophagus. The branches of the left gastric also anastomoses over the fundus with the short gastric arteries. Short gastric branches are the vessels which arise from the terminal part of splenic artery.

Gastroduodenal artery –the artery which mainly supplies the pylorus, proximal duodenum, and the head of the pancreas. It lies in the gastrohepatic omentum and passes behind the first part of duodenum to reach its lower border, where it divides into two terminal branches – the superior pancreaticoduodenal and right gastroepiploic artery. Right gastroepiploic supplies the greater curvature of the stomach and pylorus. It is found between the layers of the greater omentum, which it also supplies. Superior pancreaticoduodenal artery divides into an anterior and posterior branch, which supplies the head of the pancreas. The gastroduodenal artery arise from common hepatic artery.

Fifteen types of coeliac axis anatomy including normal coeliac axis is theoretically possible. (see table 2)

To describe the results of the systematic analysis of the coeliac axis and common hepatic artery the segments need to be defined. (Table 3)

Conclusion

With a clear definition of normal and variant CHA, we were able to perform a systematic analysis of CT images using descriptive nomenclature system and summarize the observed variations

Limitations

The number of cases studied was not adequate to be able to describe most of the variants in the population. A study with a large number of patients will be useful to verify the usefulness of the nomenclature.

The study was based on the analysis of radiologic images, depiction of fine arterial networks was not possible as was beyond the capability of CT examinations. Variation in segmental arterial branching was not studied. The implications of the classification has not been studied in surgical and interventional procedures.

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