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Prevalence-of-Anatomical-Celiac-Trunk-Variations-Using-3D-Angiography-Computed-Tomography-Images-in-a-Reference-Hospital

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Abstract

Purpose: With the advances in the new image techniques and 3D modeling, angiography computed tomography (A-CT) has become a very useful image to study vessels. Prevalence of Celiac Trunk (CeT) variations is common, and have a clinical relevance in preoperative planning. Our objective was to describe prevalence of CeT variations in a study population in Cali, Colombia.

Methods: A retrospective study with a database was made from a selection of A-CT 3D images from January 1, 2012 to September 30, 2014, from which the CeT could be visualized. Patients under 18 were excluded, also with no 3D A-CT, or not Colombian. Frequencies, percentages were calculated using Excel and STATA software.

Results: A total of 252 patients were selected, from which 10 were excluded. The most common causes of performing the A-CT were pathologies of the Aorta, followed by studies for transplantation of the kidney or liver. Variations were found in 71 (30%) patients. The most common variation was the origin of the inferior phrenic artery from the CeT in 43 (60%) patients, followed by accessories arteries to the liver in 11 (15%) patients, and the presence of a hepato-splenic trunk in 8 (11%) patients.

Conclusion: Prevalence of CeT variations in our study population was higher than that reported in other studies. The use of image techniques, such as 3D A-CT, could help the surgeon or the interventional radiologist identify these variations, preventing catastrophic complications, and making safer surgeries for our patients.

Keywords: Celiac trunk variation; Axial tomography; Angiography reconstruction; Anatomical variation

Introduction

The celiac artery or most known as the celiac trunk (CeT) is the major visceral artery in the abdominal cavity supplying major abdominal organs including: the liver, the gallbladder, the spleen, the pancreas, and from the esophagus to the duodenum [1]. Variations are defined as all other different anatomy compared to the classical division [2-4]. Cadaveric and radiological studies have reported a prevalence of CeT variations ranging from 10-12% [2-4]. None of these have been made in low-income countries.

Knowledge of CeT variations is clinically relevant, specifically to determine the blood flow to specific organs [5]. It can help in the diagnosis of specific diseases, assist in selection of treatment options and surgical planning, facilitate surgical dissection, and help avoid iatrogenic injuries [3,5]. Advances in spiral and multidetector computed tomography technology has replaced invasive procedures for the study of this vessels [6,7].

The number of minimally interventional procedures has increased worldwide, and there are many studies that have shown a positive impact in the use of the 3D Computed Tomography Angiography (A-CT scan) for surgical planning in organ transplantation surgery [5,8,9]. Our institution is a Latin American reference hospital for advanced surgical procedures such as surgery of advanced stage cancers of the abdominal cavity and transplant of major organs such as the pancreas, liver and kidneys [10]. Studies of prevalence and characterization of CeT variations have been well described in studies made in high-income countries, but there are just two made in low-income countries by date, none of them from Latin-American countries [11,12]. The purpose

of this study is to determine the prevalence of CeT variations in a local Latin-American study population using 3D A-CT images.

Methods

Patients

A retrospective study was approved by the ethics committee, and all patients were contacted to give written consent for the study. All abdominal A-CT with 3D reconstruction from January 1st of 2012 to September 30 of 2014 were included to create a database of the anatomical CeT variations, from which we exclude patients with less than 18 years at the time of the study, without 3D reconstruction A-CT, or not Colombian origin.

Image technique: Angiographic Computed Tomography

A medical-surgical specialist (vascular surgeon, transplant surgeon or oncologist) ordered A-CT to determine several characteristics of the relationship between the vessels and the organs related to diagnostic and/or treatment.

The images were obtained using a 64-row MDCT scanner (LightSpeed VCT, GE Healthcare) with a symmetrical matrix of 64 detector rows, and slice thickness of 0.625 mm. A dual head injector was used for the administration of contrast material, which allows the simultaneous injection of a compact iodine bolus followed by a normal saline bolus, both of them at the same injection rate of 4.5-5.0 ml/s.

Analyses of the images were performed on a computer with a Siemens console equipped with Syngo software and GE centricity RIS/PACS-IW Solution. A multiplane reconstruction (MPRs) in the three spatial planes and three-dimensional reconstructions (3D) using maximum intensity projection (MIP) and volume rendering (VR) was performed. Selection of the CTA images to analyze were based on those ordered as Thoracic and abdominal Aorta, renal, splenic and hepatic arteries, and contrasted total abdominal CT.

Image interpretation

All images were evaluated by two different physicians of different levels of expertise. First a resident in radiology evaluated the CT 2D axial images obtained by MDCT angiography as well as the post-processed 3D VRT, MIP and MPR images, in order to make a diagnosis. Then all images were reviewed by a former radiologist with more than 10 years of practice in corporal image A-CT.

For image interpretation RA was defined as any artery arising from the abdominal aorta or direct branches and ending in the kidney, regardless of the location and the course and any other anatomical different course were considered as a variation [13].

Statistical analyses

Frequencies and percentages were calculated using Excel® for the prevalence of RA and FMD across sex and age, and location of the anatomical variation. It was considered statistically significant a level of significance lower of 5% ($p<0.05$).

Results

There were 242 patients that fulfilled the criteria for the study, 116 (47%) males and 126 (53%) females. The mean age was 55, the median age was 58, the minimum age was 19, and maximum age was 96.

Normal anatomy or also called the normal CeT trifurcation was seen in 171 (70%) patients, and variations were seen in the other 71 (30%) patients. From those with anatomic variations of the CeT 42 (60%) were men and 29 (40%) were females ($p = 0.119$) (Table 1).

	TOTAL (%) n=71	p-value
Sex		0.119
Men Women	40 (56%) 31 (44%)	
Age		
18-35 35-50 >50	8 (12%) 14 (18%) 49 (70%)	

Table 1: Characteristics of population with CeT variations

In those patients with anatomical variations the most common cause to perform A-CT was a presumed diagnosis of any disease affecting the Aorta artery as aneurism, aneurism rupture, and aortic dissection seen in 100 (41%) patients. The second cause was related to evaluation of donors and receptors of renal or liver transplantation seen in 78 (32%) patients, the next was the study for secondary hypertension seen in 37 (15%) patients, and the last was the blank A-CT (No definitive diagnosis after CT-scan) seen

in 27 (11%) patients. The frequency of CeT variations by suspected diagnosis also followed that order, except that secondary HTN was more common than transplant studies (Table 2).

Diagnosis	Total	Variation
Aorta disease (aneurysm, dissection, stenosis)	**100**	35 (35%)
Transplant (liver, kidney)	78	21 (26%)
Secondary HTN (Renal artery stenosis)	37	12 (32%)
Blank CT*	27	2 (7%)
Total	242	71

*No definitive diagnosis after CT-scan.

Table 2: Frequency of CeT variations by suspected diagnosis

From 71 (30%) patients with CeT variations the most common found was the phrenic arteries emerging from the CeT, seen in 43 (60%) patients. The second most common variation was the presence of accessory arteries emerging from the CeT to the liver, seen in 11 (15%) patients. The third was the presence of the hepato-splenic trunk, found in 8 (11%) patients. The fourth was the presence of the gastro-splenic trunk found in 5 (7%) patients. The fifth was the presence of accessories arteries to pancreas, found in 3 (4%) patients, and the least common was the double splenic artery emerging from the CeT found in 1 (<1%) patient (Figure 1) (Table 3).

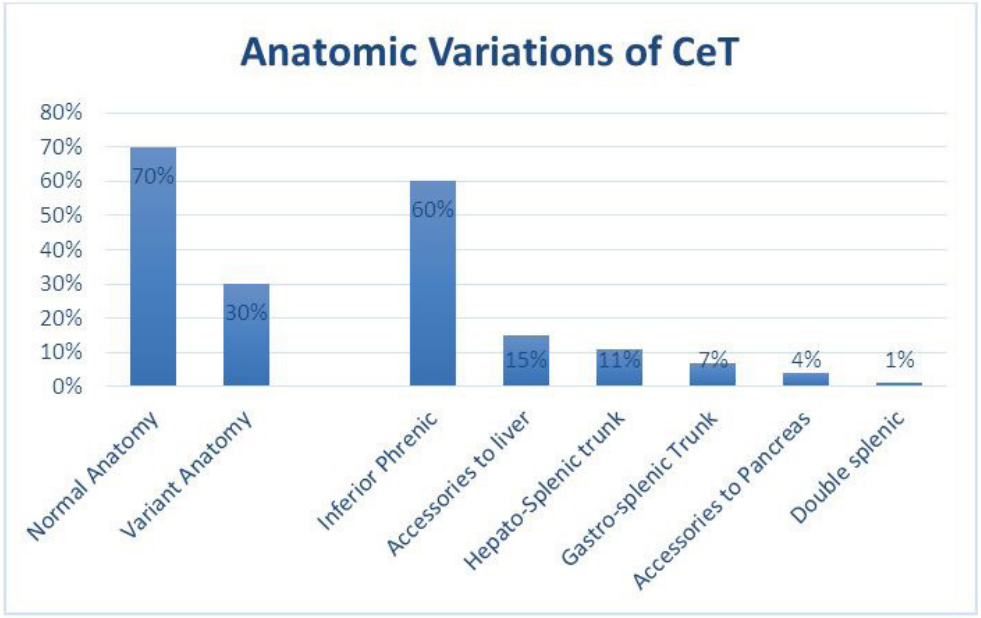

Figure 1: Distribution of anatomic variations

	TOTAL (%) n=71
Phrenic arteries	43 (60%)
Accessory arteries to the liver	11 (15%)
Hepato-splenic trunk	8 (11%)
Gastro-splenic trunk	5 (7%)
Accessories arteries to pancreas	3 (4%)
Double splenic artery	1 (<1%)

Table 3: Types of CeT variations

Discussion

Similar to other studies, the sex and mean age of the patients was close to our mean age of 55 years in males. This age of diagnosis is related to the age where people suffer more from hypertension, Aortic aneurysms, renal hypertension and chronic liver disease, so is exposed more to diagnostic images as A-CT; hence we did not find a statistical significant differences between sex [12,14-23].

The prevalence of anatomical variations of the CeT found in this study was three times higher than that reported in other studies ranging from 10-12% [4,5,14,24,25]. This difference should be revalidated in other studies with a bigger Latin American population, but at this time we didn't found any study using latin american patients.

As reported in other studies we found that the most common variation of the CeT was the origin of the inferior phrenic arteries emerging from the CeT (Figure 2A), ranging from 30-51% [2,26]. This variation specifically has been related to the treatment of hepatocellular carcinoma, in which they are a focus to catheterization to administer drugs directed to the liver, and knowing this variation can prevent damage to the patient [27]. Also the presence of Accessory arteries to the liver and pancreas (Figure 2B) was found in the same proportion as reported in other studies between 3-10% [28,29]. This variation has been related to pancreatic ischemia secondary to clipping accessories arteries to the pancreas erroneously during abdominal surgeries, liver necrosis during liver transplantation, and during pancreatoduodenectomy and laparoscopic operations of the biliary tract [30–37].

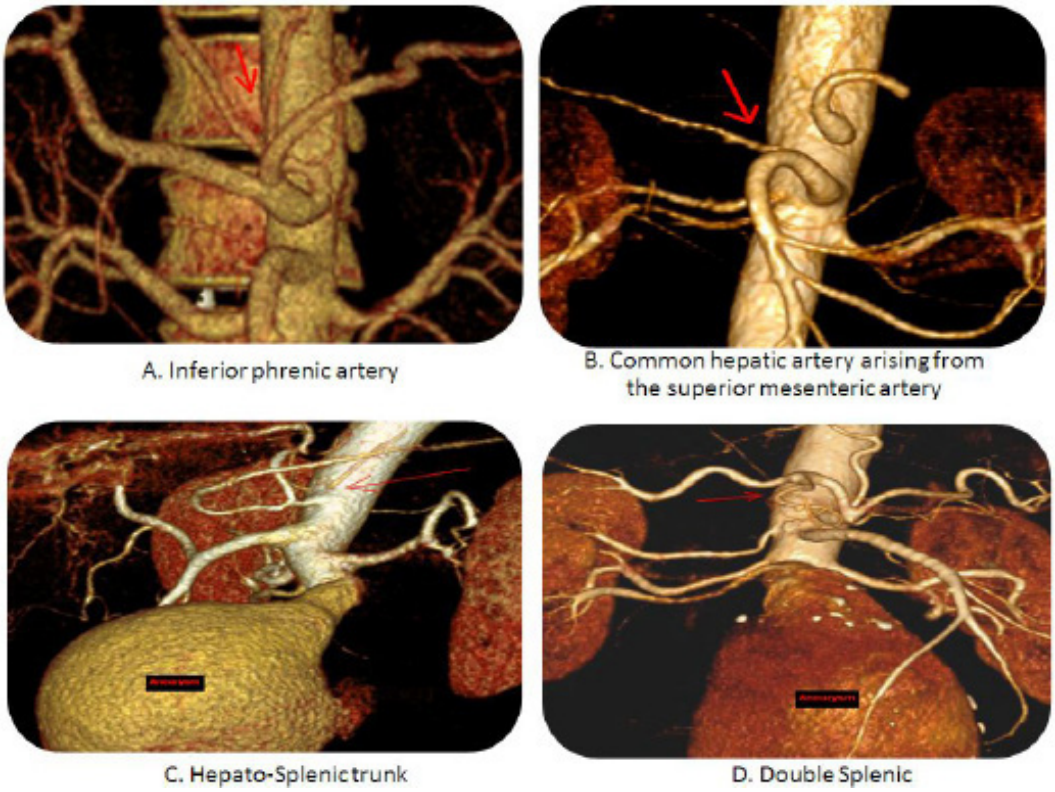

Figure 2: 3D A-CT images

Other less common variations founded was the presence of Hepatosplenic and Gastrosplenic trunks seen in 3% and 2% of the patients, that is the same prevalence reported in larger studies (Figure 2C) [14,24]. This variations are important in laparoscopic resections of the liver and stomach, where a different surgical approach is needed [29,38].

The least common variation founded in our study was the presence of a double splenic artery emerging from the CeT (Figure 2D), which also has been reported as one of the least common. The relevance of this variation has been related during splenic embolization where they need to occlude two arteries instead of the normal one to perform correctly the procedure [29,39,40].

One limitation of this higher prevalence of CeT variation is the total number of people evaluated. We used a relatively small population when is compared to other studies of this kind, but this is the first study in Latin American population, and there are reports of different prevalences among different countries [41]. The second limitation remains in the sensitivity of the A-CT when compared to morphologic post mortem studies [41,42]. The third limitation founded in our study was that we used the information from the biggest hospital in the southwest of Colombia, however this is one of the few studies in middle and low income countries, and the only one in Colombia [41,42].

Conclusion

The anatomical variations of the CeT can be found even in one each three patients undergoing to invasive images or procedures; knowing their existence could help the surgeon or the interventional radiologist to make a safer surgery and to avoid preventable complications. Additional studies are needed in different clinical settings with a higher number of participants.

Ethical committee: An ethical committee approved this study.

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