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A unique case of thoracic origin of the CT, SMA, RRA and LRA

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Abstract

Vascular anomalies are incidental findings revealed by imaging techniques such as Computed Tomography Angiography (CTA), ordered for various medical reasons. Certain variants have been observed and reported more frequently than others, while some occur infrequently. A 63-year-old patient with a medical history of hypertension, atherosclerosis and smoking but no other symptoms such as chest pain or abdominal pain, was consulted by a vascular surgeon. CTA was ordered and revealed an unusual thoracic origin of the three main abdominal arteries. The authors present the case and investigate previous reports of thoracic origin of the branches of the abdominal aorta to find out that this is the first such case in the medical literature. The thoracic origin of the abdominal arteries may predispose to the arterial compression syndromes such as the median arcuate ligament syndrome (MALS), which should be known to clinicians, surgeons and radiologists. In conclusion, imaging techniques, preferably CTA as a convenient and time-saving method, should be considered a necessity in the diagnostic process or the preoperative evaluation before vascular interventions and organ transplantation.

Keywords: Celiac Trunk (CT); Superior Mesenteric Artery (SMA); Renal Arteries (RA); Thoracic Origin; Thoracic Aorta (CTA); Anatomical Variant; Vascular Anomaly; Computed Tomography Angiography (CTA).

Introduction

Vascular anomalies are incidental findings revealed by imaging techniques such as Computed Tomography Angiography (CTA), ordered for various medical reasons. Thus, medical specialists should be aware of their occurrence and further medical implications. Vascular anomalies may come in different variants, which can also display large inter-individual variability among patients. These vascular variations may refer to the altered site of origin, branching pattern or additional/lacking blood vessels. Certain variants have been observed and reported more frequently than others, while some occur infrequently-only several such cases have been reported worldwide. The authors present a unique case of a 63-year-old patient with a complex vascular anomaly of the main abdominal arteries originating from the thoracic aorta combined with the presence of the common arterial trunk consists of SMA, RRA and LRA.

Case presentation

A 63-year-old patient with a medical history of hypertension, atherosclerosis and smoking was consulted by a vascular surgeon due to pain in the lower extremities in the course of the peripheral arterial disease. The claudication distance was about 50 meters. No other symptoms, either chest pain or abdominal pain, were present. Duplex ultrasound was performed, which revealed bilateral occlusion of the superficial femoral artery. The patient was referred for computed tomography angiogra-

phy of the thoracic and abdominal aorta for evaluation for vascular treatment/intervention, which showed:

- Multiple atherosclerotic plaques in the Thoracic Aorta (TA),

- Celiac Trunk (CT) originating from the TA 32 mm above the diaphragm at the level Th11, narrowed in the proximal part with a poststenotic widening.

- Common trunk for Superior Mesenteric Artery (SMA) and Renal Arteries (RA) originating from the TA 10 mm above the diaphragm at the level Th12,

Both the CT and the common trunk for the SMA, RRA and LRA passed through the aortic hiatus, which seemed wider by 5-7 mm than typical (its diameters in transverse plane were 33x27 mm).

Figure 1: CT examination of the thorax, MPR reconstruction, sagittal view – a typical location of the ostium celiac artery and the common trunk of the superior mesenteric artery and renal arteries above the level of the diaphragm.

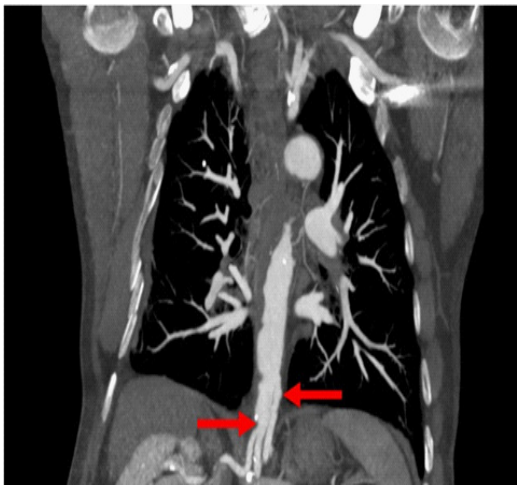

Figure 2: CT examination of the thorax, MPR reconstruction, frontal view – a typical location of the ostium celiac artery and the common trunk of the superior mesenteric artery and renal arteries above the level of the diaphragm.

Figure 3: CT examination of the abdomen, MPR reconstruction, sagittal view – a typical location of the ostium celiac artery and the common trunk of the superior mesenteric artery and renal arteries above the level of the diaphragm.

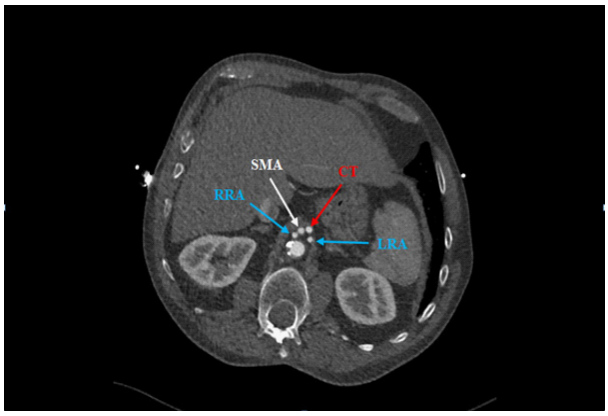

Figure 4: CT examination of the abdomen, axial view – a typical location of the ostium of the visceral arteries (CT, SMA, RRA, LRA) above the level of the diaphragm. Scan view on the level of the aortic hiatus of the diaphragm.

Apart from that, the findings included:

- Emphysema and a "mosaic" attenuation pattern of the lungs.

- Massive scoliosis of the vertebral column with thoracic vertebrae deformations and rotation.

- Multilevel ankylosis of the thoracic and lumbar vertebrae.

- Fusion of the 3rd and 4th ribs in their posterior aspects.

- Fusion of the sternal bones.

Discussion

Anatomically, CT, SMA and RA are major abdominal arteries, providing a significant amount of blood supply to the main organs of the abdomen including liver, spleen, duodenum, pancreas, jejuno-ileum, ascending colon, two-thirds of the transverse colon and kidneys. They are branches of the descending Abdominal Aorta (AA), emerging at its different levels in the following order: the CT at the Th12, the SMA at the L1 and the RA at the L1/L2 level. The descending AA is a continuation of the thoracic descending aorta as it passes through the aortic hiatus at the level of the Th12, formed by the diaphragmatic cruras and the Median Arcuate Ligament (MAL) – which from the clini-

cal point of view is a critical anatomical structure/point due to possible compression of the passing aorta and para-aortic vessels [1,2].

All of the arteries described above may present anatomical alterations, as shown in multiple studies and case reports. It seems that there are as many anatomical variants likely to occur as there are arteries. These variants may include the altered site of origin, branching pattern or accessory blood vessels. Moreover, CT, SMA and RA may display individual variability among patients or different prevalence among themselves. For instance, there are multiple studies on anatomical variants of the celiac trunk that describe various branching patterns including CA branches and SMA. In a study by Kornafel et al. the authors comprehensively analyzed anatomical variations of the main arteries branching from the AA with 64-detector computed tomography. The study was conducted on a group of 201 patients and showed that vascular anomalies of the abdominal arteries were quite frequent findings – 88 patients (43.8%) presented some kind of vascular alteration of the main abdominal arteries. The most common ones turned out to be anomalies of the renal vasculature - in 83 patients (41.3%) followed by anomalies of the CA in 9 patients (4.5%), including anomalies of the SMA in 4 patients (2%). The most common renal variant was the presence of an additional renal artery, usually in the left one, with no kidney abnormality. In both CA and SMA, the Celiaco-Mesenteric Trunk (CMT) seemed to be the most popular variation. Several studies and case reports covered the topic of the altered origin of the main abdominal arteries, which included the thoracic origin of the arteries. To our knowledge, thoracic RA, although generally considered rare have been described in 15 case reports so far. In their case report, Ji-Eun Kim gathered and compared cases of the RA originating from the TA, which showed that in the majority of these cases RA originated at the Th11 [8] and on the right site [11]. A few originated at Th12 [4], one at Th10 and a few on the left side [3]. The latest report of the thoracic renal artery was published in 2021 (Sousa et al.) and described an incidental finding of a right main renal artery arising from the thoracic aorta at the 11th thoracic level in an asymptomatic 57-year-old patient. Interestingly, no reports of bilateral thoracic RA have been described so far. Similarly, Matusz et al. presented a case of the CT and the SMA in the thorax, in which they correlated/showcased the data from previous studies on the distribution of CA, SMA and Celiacomesenteric Trunk (CMT) in relation to vertebral levels. According to the data, in early reports the vertebral levels ranged from upper one third of Th11 to middle third of L2 for the CA, whereas for the SMA they ranged from middle one third of Th12 to the intervertebral disc L2-L3. There were 2 instances of CMT at levels L1 and L1/L2. In more recent reports, authors described the following cases of a supradiaphragmatic origin of the CMT at the middle Th11 bifurcating into the CT and the SMA at the L1-L2, an anatomical variant of the CT originating above the aortic hiatus at the Th12-L1 and SMA at the lower L1 and supradiaphragmatic origin of the CT and the SMA at the Th12/L1 and middle L1, respectively. In another study, Rusu et al. investigated aortic origins of the CT and the SMA in correlation to vertebral level in 107 patients and managed to classify them. According to their classification system, types 1-3 corresponded with the Th12 level and types 4-11 with L1-L2 levels.

On the other hand, to the authors' knowledge, there are no studies or case reports of all three main abdominal arteries – CA, SMA, RA – originating contemporaneously from the thoracic aorta in one patient [3-7]. Thus, the authors present a unique case of a patient with CA, SMA and RA originating from the TA, combined in one individual. Moreover, the thoracic origin of the main abdominal arteries was associated with another vascular anomaly, i.e. a common trunk for the SMA and both RA. Interestingly, in previous reports a common vascular trunk was rather a combination of CA and SMA, further called the celiacomesenteric trunk. From the clinical point of view, such vascular anomalies are not only an interesting finding but also a crucial medical matter of possible symptoms and therefore potential preoperative evaluation. As a matter of fact, the thoracic origin of an artery may potentially predispose to the triple vascular compression syndrome due to the proximity of the structures of the aortic hiatus. In association with the CA, SMA and RA, the following compression syndromes may develop: celiac artery compression syndrome (also known as median arcuate ligament syndrome, Dunbar syndrome), superior mesenteric artery compression syndrome and renal artery compression syndrome. The first two have been investigated by Matusz et al. in correlation to such factors as origin levels of the CT, SMA and MAL, an aortomesenteric angle and aortomesenteric distance. Although the patient in that case did not present any symptoms of the entrapment syndrome, the authors claimed that the risk of the CT and SMA compression in patients with supradiaphragmatic origin of these arteries was significant, which was based on / justified by previous cases in literature. Similarly, the compression of the renal artery by the MAL due to supradiaphragmatic origin has been documented by some authors and manifested clinically as renovascular hypertension. Generally, symptomatic patients with coexisting compression syndromes may complain of bloating, weight loss, nausea, vomiting, abdominal pain or symptoms of renal stenosis such as renal hypertension, hematuria, elevated protein levels in the urine, gradual loss of kidney function. But patients may also remain asymptomatic.

Last but not least, variability in the abdominal vasculature has a high relevance in the preoperative assessment due to altered anatomy, which should be known by surgeons, interventional and diagnostics radiologists [3,6,8]. The occurrence of vascular variants should also be considered before renal transplantation as it might carry the risk of some iatrogenic complications. Anatomical variants and vascular anomalies are usually detected by Multidetector Computed Tomography (MDCT) angiography ordered before surgical/endovascular intervention, which seems to be a suitable imaging technique for the purpose of preoperative diagnostics. Additionally, three dimensional reconstructions might be helpful in visualising to the full extent altered anatomical conditions and planning surgical/intravascular treatment.

Conclusion

In literature, case reports may be found of various vascular variants and anomalies of different arteries, including major branches of the aorta [3-5]. Some of them appear more frequently than others, for instance the diverse branching patterns of the CT. Variants of the origin of the CT, SMA and RA are considered less frequent – in literature they have only appeared in several studies and case reports. The authors present a unique case of thoracic origin of the main abdominal arteries, in which all three arteries emerged from the thoracic aorta. In previous literature, thoracic origin of the CT, SMA and RA has been reported but only in reference to one of them. Interestingly, there has never been a case of bilateral RA emerging from the TA either. Although rare, anatomical variants of the abdominal arteries – especially these particularly uncommon – should

be reported and described in medical literature to promote knowledge about them among medical specialists. In conclusion, imaging techniques, preferably CTA as a convenient and time-saving method, should be considered a necessity in the diagnostic process or preoperative evaluation before vascular interventions and organ transplantation.

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