Rare origin and course of left testicular artery associated with phrenico-adreno-gastric trunk

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Abstract
Introduction
The testes receive its blood supply from the testicular arteries. Variations in origin, number and course of these vessels are often reported. However, in the present case we discuss unusual origin and course of left testicular artery, its embryology and clinical significance.

Case report
A rare case of an unusual origin and course of left testicular artery associated with other vascular anomalies was observed in an 88-years-old Japanese male cadaver. The artery originated as a continuation of the phrenicoadrenogastric trunk from the right side and shifted to the left to give dual arterial supply to the left testes.

Conclusion
Understanding these anatomical variations of the testicular arteries and great vessels of the upper abdomen will append to existing knowledge explaining their morphological and clinical significance.

Introduction
The testes receive its blood supply from the testicular arteries that are known to originate from the ventrolateral aspect of the abdominal aorta. Variations relating to these arteries have been reported and discussed by many researchers and they were often found to coexist with other branches arising from the abdominal aorta1,2.

These developmentally-based variations in origin, number and course of the testicular arteries may arise due to persistence of vessels normally obliterated3 or development of testis in two segments of the body4.

However, in the present case we are reporting a novel finding that involve the origin and course of the left testicular artery observed during the routine dissection class of the undergraduate medical students.

Phrenicoadrenogastric trunk
Phrenicoadrenogastric arterial trunk was observed originating from the abdominal aorta above the origin of the celiac artery. It measured 1.1cm long and gave off left and right branches before continuing as left gastric artery. The left branch gave left inferior phrenic artery, left suprarenal arteries (superior, middle and inferior) and terminates by joining the left renal artery (Figure 1). The right branch gave right inferior phrenic artery, right suprarenal arteries (superior, middle and inferior) and continued as lateral left testicular artery (Figure 2).

Testicular arteries and veins
In our observations on the testicular arteries we noticed variations on the origin, course and number supplying the left testes. It had dual arterial supply; lateral (major) and medial (minor) testicular arteries.

The left lateral testicular artery was larger in caliber (2.5 mm) arises as the continuation of the right branch of phrenicoadrenogastric trunk (Figure 2).

It ran caudally then curved medially towards the midline above the origin of the right renal artery, crossing the midline to the left passing between the superior mesenteric artery and abdominal aorta (Figure 1, Figure 2 and Figure 3). Afterwards it passes above the left renal artery and loops inferiorly between the main left renal vein and the accessory left renal vein (inferiorly) and descends towards the left testes in the common vascular cord with medial left testicular artery and left testicular vein.

The left medial testicular artery was smaller in caliber (1.5mm) arising from anterior part (ventral surface) of the abdominal aorta 2.3 cm above the origin of the right testicular artery, 3.5 cm from the origin of inferior mesenteric artery, and 3.1 cm below the origin of the Left renal artery. It run inferolaterally to the left then descends to the left testicle (Figure 4).

The right testicle was supplied by one testicular artery originated from the lateral aspect of the abdominal aorta, 6
mm superolateral to the origin of the inferior mesenteric artery (Figure 3).

Left testicle was drained by a single vein, accompanied with medial and lateral testicular arteries in a common vascular cord, and drain as a tributary of the accessory left renal vein (hilar vein) (Figure 1 and Figure 4).

Two testicular veins were observed draining the right testicle; lateral drains into the right renal vein while the medial drains into the inferior vena cava (Figure 3).

**Associated variations**
Both kidneys were polycystic kidneys. Left kidney was observed to have supernumerary arteries and veins (hilar and polar) and extrarenal pelvis which measured 3.5cm long and 1.5cm wide (Figure 1 and Figure 2). Right kidney also had supernumerary vessels but no extrarenal pelvis.

**Discussion**
Variations involving the blood supply to the testicles are not uncommon and have been linked with their embryologic derivation from the segmental arteries supplying the mesonephrones. Testicular arteries may vary in their origin, number and course. These variations are clinically and surgically important.

The presence of double arterial supply to the left testicle (medial and lateral left testicular arteries) have previously been reported, however, in all these cases both arteries originated from the same side of the testicle. In the present case, the lateral left testicular artery did arise from the right side (right branch of phrenicoadrenogastric trunk) then crossing midline to supply the left testes. This is a novel finding and has not yet been reported.

Several researchers reported that, the position of testicular arteries origin to be anterolateral or lateral aspect of the abdominal aorta, however, in the present case the medial left testicular artery arise from the anterior (ventral) surface of the abdominal aorta which correlates with Brohi et al., but in their case it was with high origin at the level of the left renal artery.

![Figure 1](image1.png)

**Figure 1:** Photograph from 88-years-old embalmed male cadaver showing the left view of the upper abdomen great vessels. Note the left gastric artery (LGA) arising from phrenicoadrenogastric trunk (PAGT) and left branch of PAGT (Asterisks) joining the left renal artery (Not shown). CT: celiac trunk; SMA: superior mesenteric artery; LGA: left gastric artery; AO: abdominal aorta; ERP: extrarenal pelvis.

![Figure 2](image2.png)

**Figure 2:** Photograph from 88-years-old embalmed male cadaver showing the right view of the upper abdomen great vessels. Note the right branch of phrenicoadrenogastric trunk (Asterisks) and its distributing vessels before terminating as left lateral testicular artery (LLTA). SMA: superior mesenteric artery; CT: celiac trunk; LGA: left gastric artery; AO: abdominal aorta; RIP: right inferior phrenic artery; RSSA: right superior suprarenal artery; RMSA: right middle suprarenal artery; RPA: accessory right renal artery; LRV: left renal vein; AO: abdominal aorta; LLTA: lateral left testicular artery; MLTA: medial left testicular artery; ERP: extrarenal pelvis.

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Variations in the origin of inferior phrenic and suprarenal arteries have been reported\textsuperscript{17,18,19} and may arise from celiac artery, aorta, coronary, renal or superior mesenteric arteries\textsuperscript{4,6}.

Onderogju et al.\textsuperscript{20} reported a right testicular artery which gave off inferior phrenic and superior suprarenal arteries. In the present case, we observed all adrenal arteries (superior, middle, inferior), inferior phrenic and left gastric arteries arising as a common trunk (phrenicoadrenogastric trunk) from abdominal aorta and terminated as left testicular artery is also unique and being reported for the first time.

Knowledge on these variations is important during procedures like laparoscopic adrenolectomy or adrenal artery aneurysm management.

Although left gastric artery usually originated from the celiac trunk, variations have been reported. It may originate directly from the aorta\textsuperscript{2,21,22,23} or from common trunk with hepatic artery\textsuperscript{24}. In the present case, we observed arising directly from abdominal aorta in a common trunk with inferior phrenic, suprarenal and left testicular artery.

The existence of phrenicoadrenogastric trunk with left gastric arising from it has not been reported yet. Awareness on this variation is important with regards to the diagnosis, surgical management and endovascular interventions related to great vessels of the upper abdomen.

Accessory renal blood supply is often being reported and may arise from different levels of the abdominal aorta, common iliac or internal iliac arteries and usually enter towards one pole of the kidney\textsuperscript{25}. In the present case, we observed the left branch of the phrenicoadrenogastric trunk terminated as an anastomosis to the left renal artery.

This also is a unique finding and of clinical important for routine surgical and radiological procedure performed on this region.

**Embryological note**

Variations in the vascular supply for the adrenal, diaphragm and gonads (testicles) are of common occurrence and are originated from the pattern of branching of the arteries to the para-aortic ridge\textsuperscript{26}.

They may be due to the choice of unusual paths in the primitive vascular plexuses; to the persistence of vessels normally obliterated; to the disappearance of vessels normally retained; to incomplete development; and to fusions and absorption of parts usually distinct\textsuperscript{3}.
During developmental modification of the gastrointestinal tract, the celiac splanchnic (ventral segmental) arteries are gradually disappearing. Any defect on this could lead to anatomical variations among the definitive arteries arising from ventral segmental arteries. Cunningham4 claimed that, retention of a greater number of the splanchnic arteries than usual, obliteration of the root of original vessel and enlargement of an anastomosis between the intermediate visceral arteries of adjacent segments may lead to formation of common trunk of vessels. This could be the explanation of the existence of phrenicoadrenogastric trunk observed in the present case.

Testicular, inferior phrenic and suprarenal arteries are normally developed from lateral segmental arteries which are branches of dorsal aorta (abdominal segment), and their variations can be embryologically explained by Felix’s ladder theory27.

It has been reported that occurrence of two testicular arteries on one side is probably an indication that the testis was developed in at least two segments of the body4. However, in our case the two left testicular arteries originated at different levels and different branches of segmental arteries. The lateral left testicular artery originated as a fusion of lateral branches of segmental arteries above the celiac artery.

The medial left testicular artery was located at the anterior (ventral) surface of the abdominal aorta at the middle position between the origin of superior mesenteric artery (above) and inferior mesenteric artery (below) hence appear to be derived from the ventral segmental branches of dorsal aorta. This means that caudal part of the para-aortic ridge could also receive blood supply from the distal ventral segmental branches as a compensatory mechanism following obliteration or disappearance of lateral segmental arteries to the mesonephrone.

During development urogenital ridge normally shift laterally in its position on both sides, and cranial part of the para-aortic ridges expand laterally and differentiate into suprarenal gland while the caudal part of the ridges migrates medially and fuse to form gonadal rete blastema25, Failure or delayed on lateral shifting of the urogenital ridge could be the reason for the left testes to receive arterial supply from the right side due to the persistence of vessels normally obliterated.

Embryological development involves well programmed timed events; delay on lateral shifting of the urogenital ridge, as described by Isogai et al.,26 may lead to fusion of the vessels which normally separate. This could be the reason underlying our case where left gastric (from ventral branches) form a common trunk with the inferior phrenic, suprarenal and testicular arteries.

Some of the segmental arteries that supply the respective parts of the urogenital ridge get obliterated while others are fused and persist to form the adult arteries of the organs developed from it27. Branches that supplied the cranial half of the para-aortic ridge become thickened and form the definitive adrenal arteries and inferior phrenic arteries, while those on the caudal part form the testicular (gonadal) arteries.

Isogai et al.,26 reported that the genital ridge is supplied by the branches to the cranial half of the para-aortic ridge but the differentiating testicular primordia were supplied by branches to the caudal half of the para-aortic ridge in later stages of embryonic life.

This indicates that, if there is a failure in the alteration or fusion of blood supply from cranial to caudal half, could lead to formation of common arterial trunk supplying the testes (gonads), diaphragm and suprarenal gland. This could possibly explain the observations on the present case.

Conclusion

Even though many kinds of origin, number and course of left testicular artery have been described, the presence of phrenicoadrenogastric trunk with lateral left testicular artery arising from the right side is a rare case, and first to be reported.

This novel observation is attributed to modifications of the developmental processes by which the vessels and respective organs are developed. Understanding of such anatomical variations of testicular arteries and great vessels of the upper abdomen is of clinically importance for urologists, radiologists and surgeons undertaking routine procedures involving the regions supplied by these vessels.

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References

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