Aberrant inferior suprarenal vessels crossing posterior pararenal space: a case report

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ABSTRACT

During routine educational dissection of a cadaver (63-year-old, male, USA), an atypical course of the left inferior suprarenal vessels via the posterior pararenal space was discovered. Detailed analysis of the abdominal vascular pattern showed that the atypical inferior suprarenal artery represented a terminal branch of the left inferior phrenic artery. The last one branched off from the very beginning of the left renal artery, ascended between the fibers of the left crus of the diaphragm, then ran laterally giving off muscular branches and, finally, descended along the costal part of the diaphragm to the left posterior pararenal space. The terminal branch of the inferior phrenic artery pierced the retrorenal fascia and entered the perirenal space as an atypical left inferior suprarenal artery. It ran upward and medially crossing the anterior surface of the kidney to reach and supply the lower pole of the left suprarenal gland. The left inferior phrenic vein accompanied the artery taking a similar course. It received numerous tributaries passing via the posterior pararenal space, drained the inferior suprarenal vein, and opened into the left renal vein. Such anomalous pararenal vascular pattern is a challenge for surgeons performing open procedures on retroperitoneal organs, not to mention specialists employing minimally invasive laparoscopic techniques. The anatomical variation reported in this paper requires urgent attention of the related specialists.

Keywords: inferior phrenic artery, inferior suprarenal artery, accessory renal vessels, pararenal space.

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Introduction
The abdominal aorta gives off visceral, posterior, and lateral branches to supply the viscera of the abdominal cavity, posterior wall of the abdomen, and the structures of the retroperitoneal space, respectively. The lateral abdominal aortic branches nourishing the diaphragm and retroperitoneal organs are represented by paired inferior phrenic, middle suprarenal, renal, and gonadal arteries. Each of these arteries may contribute to perfusion of the adrenal glands giving off superior, middle, and inferior suprarenal branches, thus supporting a wide range of anatomic variability in this region.

The previous anatomical studies on the variability of the adrenal gland vasculature have revealed that the superior suprarenal artery branches off from the inferior phrenic artery in 83.3% of cases; however, it also may be a direct branch of the aorta [7]. The middle suprarenal artery typically originates from the inferior phrenic artery (77.4%), though, it may also be a branch of the renal artery (12.9), or may even take off from the celiac trunk (9.6%) [1]. The inferior suprarenal artery is considered the most important one, as it supplies a large part of the gland. In 70% of cases, it arises from the renal artery, but also may take origin directly from the abdominal aorta [1, 6]. The origin of the inferior suprarenal artery from the inferior phrenic artery has never been reported before.

In all cases described in the literature, the suprarenal arteries took the shortest course from the point of origin to the parenchyma of the gland. In this paper, we report a unique aberrant inferior suprarenal artery, which crossed the posterior pararenal space, pierced the retrorenal fascia and reached the inferior pole of the adrenal gland passing obliquely upward and medially in front of the left kidney. The accompanying inferior phrenic vein received the inferior suprarenal vein and contributed to the renal vein on the same side of the body.

The presence of the aberrant vessels crossing the anterior surface of the kidney is a potentially risky anomaly for the open surgical procedures on the adrenal gland, kidney, and ureter via the posterior and posterolateral approaches due to compromised visualization. Broad implementation of the minimally invasive surgical technics in this region such as retroperitoneoscopic adrenalectomy and nephrectomy [2,9] requires a thorough understanding of the range of vascular variability in this region and detailed analysis of rare anatomical cases like ours.

Case Report
During the routine educational dissection of a cadaver (63-year-old, male, USA), an atypical course of the left inferior suprarenal vessels via the posterior pararenal space associated with the presence of accessory renal vessels was discovered.

The left inferior phrenic artery, 2.4 mm in diameter, branched out from the very beginning of the left renal artery and ascended between the fibers of the left crus of the diaphragm, giving off no branches to the suprarenal gland in 83.3% of cases; however, it also may be a direct branch of the aorta [7]. The middle suprarenal artery typically originates from the inferior phrenic artery (77.4%), though, it may also be a branch of the renal artery (12.9), or may even take off from the celiac trunk (9.6%) [1]. The inferior suprarenal artery is considered the most important one, as it supplies a large part of the gland. In 70% of cases, it arises from the renal artery, but also may take origin directly from the abdominal aorta [1, 6]. The origin of the inferior suprarenal artery from the inferior phrenic artery has never been reported before.

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The presence of the aberrant vessels crossing
contributed to the left renal vein (Figure 1).
Additionally, the content of the hilum of the kidney was altered by the presence of an accessory renal artery arising from the aorta, 1.8 mm below the origin of the proper renal artery on both sides. The proper renal artery gave off three pre-segmental branches, two of which entered the hilum of the kidney, but one ended up as an aberrant renal artery and entered the upper pole of the kidney by piercing its substance. The accessory renal artery bifurcated into pre-segmental branches, entering the lower part of the kidney’s hilum independently.

Diagram 1. Schematically represented early development of the lateral splanchnic arteries (lsa) into the superior suprarenal (ssr), middle suprarenal (msr) and inferior suprarenal (isr) arteries; A - regular branching pattern of the inferior phrenic (IPA) and renal (RA) arteries; B – alternated branching pattern with migration of the isr and ssr sprouts; C – proliferation of the aberrant inferior suprarenal artery (aISR) via the posterior pararenal space (presented case). Other abbreviations: MD – mesonephric duct; UB – ureteric bud; AA – dorsal aorta; AG – adrenal gland; K – kidney.
Figure 1. Cadaver dissection view showing an aberrant inferior suprarenal artery (aISR) crossing the left kidney anteriorly. The atypical inferior phrenic vein (aIPV) follows the artery, receives the tributary from the lower pole of the adrenal gland (black arrow), and contributes to the renal vein (RV) along with the regular suprarenal vein (white arrow). The superior and middle suprarenal arteries (SSR and MSR, respectively) branch off from the abdominal aorta via a common suprarenal trunk (CSRT), while the inferior phrenic artery (IPA) does not give any suprarenal branches at its origin. An accessory renal artery (aRA) appears bellow the renal artery proper (RA); both give off pre-segmental branches approaching the hilum of the kidney (asterisks).

Figure 2. Cadaver dissection view showing the contents of the left posterior pararenal space. The atypical inferior phrenic artery and vein (aIPA, aIPV) descend from the costal part of the diaphragm (CD) and pierce the retrorenal fascia (RRF). Several venous tributaries (arrows) enter the atypical venous vessel in the posterior pararenal space; TF – transversalis fascia.
Figure 3. Cadaver dissection exposing the perirenal space, anterior view. The retrorenal fascia (RRF) is pierced by the atypical inferior phrenic vein (aIPV) and aberrant inferior suprarenal artery (aISR); RRF – retrorenal fascia.

On the right side of the body, the arrangement of suprarenal vessels did not show any peculiarities. The inferior phrenic artery gave off the superior suprarenal artery, the middle suprarenal artery branched off from the abdominal aorta, and the inferior suprarenal one ascended from the right renal artery.

Discussion

The renal vessels start to develop in the mesenchyme of the aorta-gonad-mesonephros region in an embryo 2.0 mm length [3]. The rete peri-intestinale surrounding the hindgut establishes paired connections with the caudal part of the dorsal aorta via the numerous sproutings, referred to as rami intestinale. These rami develop into somatic, ventral splanchnic, and lateral splanchnic arteries nourishing the body wall, digestive tube, and mesonephric ridge, respectively. One gonadal and three suprarenal arteries, derivatives of the lateral splanchnic arteries, persist on each side of the developing mesonephros, metanephros, gonad, and the adrenal gland [3]. The inferior phrenic artery branches from the most cranial suprarenal artery, the middle one continues to supply the adrenal gland becoming the middle suprarenal artery, while the renal artery arises from the most caudal one (Diagram 1, A).

The formation of the vascular pattern reported in our case implies multiple re-arrangements of the lateral splanchnic arteries, with significant alteration of their branching pattern. We can assume that the cranial splanchnic artery developed into the inferior phrenic artery, the caudal lateral splanchnic artery became the renal artery proper, and only the middle one reached the adrenal gland as the typical middle suprarenal artery (Diagram 1, B). The sprouting of the inferior suprarenal artery from the inferior phrenic artery, as well as the growing of the superior suprarenal artery from the vascular wall of the middle one, may be explained, in part, from a position of molecular regulation of embryonic angiogenesis.

The proliferation and free migration of the endothelial cells require an interplay between the various forms of vascular endothelial growth factors (VEGF), angiopoietins (Ang), fibroblast
growth factors (FGFs) and their receptors [4]. Modern genetics provides clear evidence that the receptor for VEGF-C is highly expressed during embryonic vascular remodeling [10]. A large group of 14 membrane-bound tyrosine kinases receptors to ephrins (Eph receptors) are involved in angiogenesis and can induce sprouting [4, 11]. Although the molecular mechanisms determining the exact localization of endothelial sprouting is mostly a mystery, we can assume that shifting of the codons responsible for the expression of these receptors could alter their following localization in the endothelial wall and lead to the migration of the “sprouting points” of the vessels.

Recent investigations proved that the surrounding peri-endothelial cell layers and extracellular matrix influence the formation of particular vessels. In his research, Gomez revealed that renin is a trigger factor for the branching of the renal arteries [5]. Results of Shifren et al. showed that a complex interplay between the VEGFA cytokine and the adrenocorticotrophic hormone determines the development of the suprarenal vasculature [8]. Thus, the local factors could stimulate the proliferation of the shifted sprout of the inferior suprarenal artery through the posterior pararenal space towards the target, resulting in the formation of the atypical vessels (Diagram 1, C).

The anatomical variability reported in this paper requires urgent attention of the related specialists, as it may significantly complicate surgical and minimally invasive procedures on the organs of the retroperitoneal space. Thorough preoperative investigation of the patients considered for intervention on the adrenal gland and kidney on the subject of the variability of the vascular pattern is essential in such cases.

References: