

## ORIGINAL PAPER

# Suprarenal gland–arterial supply: an embryological basis and applied importance

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### Abstract

Variation arterial anatomy of suprarenal gland is significant for radiological and surgical interventions. Knowledge of anomalous suprarenal artery is required to avoid complications in surgical procedure. Arterial architecture of human suprarenal gland was studied in sixty-eight cadavers of adult male and female. In all cases, superior suprarenal artery on right side was normal in origin but on left side, 24% showed anomalous origin. The incidence of anomalous origin of middle suprarenal artery on right side was 47% and on left side 6%. Anomalous origin of inferior suprarenal artery on the right side was 29% and left side 35%. The superior suprarenal artery was present in all subjects. However, there was absence of right middle suprarenal artery in 29% and left inferior suprarenal artery in 35% subjects. The most variable group was inferior suprarenal artery. The study result is being described to report anomalous origin of suprarenal arteries in the light of surgical, radiological and embryological significances. Present study findings suggest, thorough knowledge of anomalous arterial anatomy of suprarenal gland is required for surgical and radiological interventions of retroperitoneal organs of upper abdomen to avoid complications.

**Keywords:** adrenal/suprarenal gland and arterial supply, abdominal aorta, accessory renal artery, renal artery, gonadal artery.

### □ Introduction

The suprarenal glands are highly vascular and receive blood flow is about 5 mL per minute [1, 2]. The required demand is supplied by three small arteries: superior, middle and inferior suprarenal arteries. These arteries are end arteries [3]. Arterial architecture of suprarenal glands is species specific. There is presence of subcapsular arterial plexus and supply centripetally in cat and rat [2, 4]. In human and dog, there is presence of capsular arteriolar plexus and cleft like intra-adrenal sinusoids. These sinusoids present surrounding the cells of cortex and medulla of the gland [3, 5–7].

Knowledge of variation arterial architecture of the suprarenal gland is required for surgical and radiological interventions of upper abdomen. Therefore, it is essential to have vivid knowledge of normal and anomalous arterial pattern of the suprarenal gland to avoid the complication during surgical intervention of the region [8, 9]. Moreover, preoperative vascular evaluation is mandatory in planning radiological and surgical procedures of the subphrenic region of the upper abdomen with emphasis on the extrahepatic collateral arteries [10–13].

The available literatures enlighten on variable origin of the superior suprarenal artery (SSA), middle suprarenal artery (MSA), inferior suprarenal artery (ISA) as well as in their branching pattern [10, 14–21].

The present paper was aimed to study the arterial architecture of the human suprarenal gland in the light of its applied importance and embryological basis.

### □ Material and Methods

Sixty-eight human cadavers were studied since 1999 to 2008. There was no apparent anomaly observed in any cadaver. Abdominal cavity was opened by median incision from the tip of the xiphoid process to the symphysis pubis. To approach upper segment of posterior abdominal wall, the peritoneum along with stomach and small intestine were reflected for better visualization. Further dissection was performed to explore branches of abdominal aorta and arterial architecture of suprarenal gland. Arterial pattern of both sides were studied carefully. In view of arterial architecture of the gland; suprarenal vein, lymph vessels, connective tissue, fats were meticulously cleared off.

The study was done on the human cadavers. Those were provided for undergraduate students study. Therefore, need not to get ethical committee permission of the Institute.

### □ Results

No aberrant origin was observed on the right SSA (Table 1). Where as on the left side 52 cases showed normal origin of SSA as described in textbooks. In 12 subjects, SSA originated from lateral margin of abdominal aorta (Figure 1) and four cases from the splenic artery.

Middle suprarenal artery of right side was normal origin in 36 cases. Anomalous origin was in 12 subjects from right accessory renal artery and 20 cases were

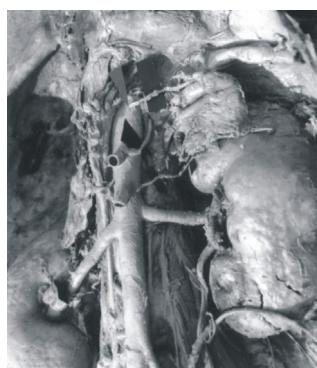
absence of MSA on the right side (Figure 5). On left side, 64 subjects were normal in origin and four cases left MSA originated from left accessory renal artery (Figure 2).

Inferior suprarenal artery on right side observed 52 cases normal in origin. Aberrant origin was in 16 subjects, of whom 12 cases were from right gonadal

artery (Figure 3) and four cases were directly from right lateral margin of abdominal aorta. On left side, 40 cases were normal pattern of origin. Four cases were from gonadal artery (Figure 2). Absence of left ISA observed in 24 subjects (Figure 4). It was observed that presence of more than one ISA in absence of MSA (Figure 5).

**Table 1 – Patterns of suprarenal artery in human (n = 68)**

	Right side	Left side
SSA	<ul style="list-style-type: none"> <li>▪ 68 (100%) cases from the inferior phrenic artery (IPA).</li> </ul>	<ul style="list-style-type: none"> <li>▪ 52 (76%) cases from ipsilateral IPA;</li> <li>▪ 12 (18%) cases from the abdominal aorta;</li> <li>▪ 4 (6%) cases from the splenic artery.</li> </ul>
MSA	<ul style="list-style-type: none"> <li>▪ 36 (53%) cases from lateral margin of abdominal aorta;</li> <li>▪ 12 (18%) cases from ipsilateral accessory renal artery;</li> <li>▪ 20 (29%) subjects were absent.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 64 (94%) cases from lateral margin of the abdominal aorta;</li> <li>▪ 4 (6%) cases from the ipsilateral accessory renal artery.</li> </ul>
ISA	<ul style="list-style-type: none"> <li>▪ 52 (76%) cases from the right renal artery;</li> <li>▪ 12 (18%) cases from gonadal arteries;</li> <li>▪ 4 (6%) cases from the right lateral margin of abdominal aorta.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 40 (59%) cases from the left renal artery;</li> <li>▪ 4 (6%) cases from the left gonadal artery;</li> <li>▪ 24 (35%) subjects were absent.</li> </ul>



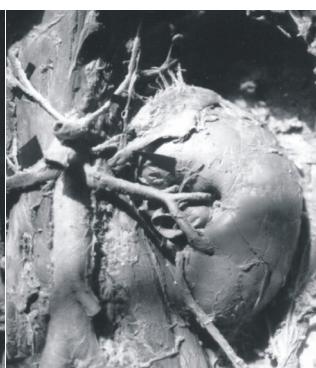
**Figure 1 – Superior, middle and inferior suprarenal arteries were originated from abdominal aorta.**



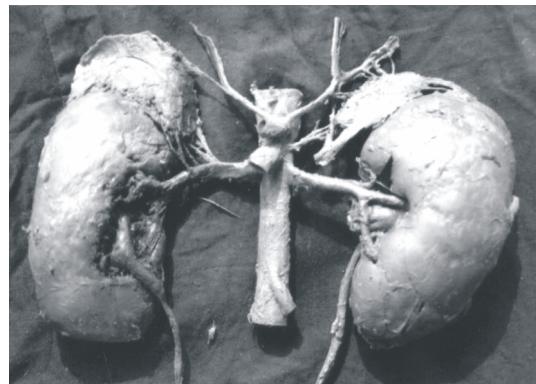
**Figure 2 – Origin of ISA from left gonadal artery (GA).**



**Figure 3 – Origin of ISA right gonadal artery and on left side and normal absence of MS.**



**Figure 4 – Absence of ISA on left side and normal origin of SSA and MSA.**



**Figure 5 – On the right side absence of MSA, more than one ISA. On left side, absence of ISA.**

## Discussion

The suprarenal gland is supplied by SSA branch of inferior phrenic artery, MSA branch of abdominal aorta and ISA branch of renal artery of the respective side [5, 22–26]. The present study result is unique in comparison with earlier studies [10, 14–17, 19–21, 25, 27–29]. The observations are as follow:

Origin of right SSA was from right IPA in all subjects which differ from earlier report of Manso JC and DiDio LJ, 2000 [14]. In 76% cases, left SSA originated from ipsilateral IPA, which was lower

incidence in contrast with earlier study [14]. Aberrant origin of left SSA was observed in 24% cadavers, of which, 18% were from lateral margin of abdominal aorta and 6% from splenic artery.

Middle suprarenal artery, on right side 53% and left side 94% cases originated from abdominal aorta as described in textbook. 18% right and 6% left MSA, originated from accessory renal artery. There was absence of right MSA in 29% subjects. Present study result of MSA differs from the earlier studies [14, 16, 27].

Anomalous origin of inferior supra renal artery was reported from aorta, supplementary renal artery, gonadal artery, genital artery, and rarely from celiac trunk [15, 17, 19, 21, 25, 28]. Present observation reveal that origin of right ISA in 76% and left ISA in 59% subjects were normal, from ipsilateral renal artery. In 18% of right ISA and 6% left ISA, originated from the gonadal artery. In 6% cases right ISA originated from lateral margin of abdominal aorta. Left ISA was absent in 35% subjects. There was presence of more than one ISA, in absence of MSA. Probably those branches were contributing the amount of blood was destined to supply by MSA.

According to Djonov V *et al.* (2000) [30], blood vessels formation is achieved by vasculogenesis and angiogenesis. However, intussusceptive microvascular growth and intussusceptive arborization are responsible

for vascular growth and remodeling. Arterial supply of kidneys, adrenal glands and gonads derives from rete arteriosum urogenitale, which is formed by lateral splanchnic branches of dorsal aorta [31, 32].

According to Felix W (1912) [31], there is presence of approximately nine lateral mesonephric arteries and are divided into cranial, middle and caudal groups. The cranial group is comprising of first and second arteries that pass dorsal to adrenal body; middle group: third, forth and fifth arteries which pass through adrenal bodies of respective side; caudal group: sixth, seventh, eighth and ninth arteries which remain ventral to adrenal bodies. These arteries normally disappear in caudal direction except those supplying metanephros, gonads, and suprarenal glands. Perhaps persistence of one branch other than normal one, may explain the cause of anomalous origin of artery as stated by Kocabiyik N *et al.* (2004) [33] to explain embryological basis of accessory renal artery. Mizukami S *et al.* (1992) [25] reported, anomalous origin of ISA from gonadal artery is directly related to development of artery. However, Xue HG *et al.* (2005) [34] mentioned development of testicular arteries are complex. Normally, gonadal arteries are developed from one of the caudal group of lateral mesonephric artery.

Presence of sufficient quantities of signal molecules and growth factors are essential for normal development of any organ. These signals must be recognized and interpreted by the developing and migrating cells of embryo [35]. Improper signaling and incorrect gradient produce visceral anomalies. Shoja MM *et al.* (2007) [36] mentioned, the particular signal which is responsible for development of an aberrant artery is unknown. However, certain known factors may play a role to develop vascular anomalies: teratogenic chemical agents, hemodynamic process, growth factors, genetic factor [37, 38].

Various factors are being identified for branching of vessels: (i) a new branch may sprout due to angiogenic stimulus from the surrounding mesenchyme, (ii) transendothelial cell bridges may divide the vessel, (iii) intussusception is a process by which vessels may branch [30, 39]. Hence, a branch when sprout from the lateral mesonephric artery to adrenal body from which gonadal artery developed, may explain gonadal artery origin of ISA. Similarly, anomalous origin of SSA, MSA and ISA from different arteries may be explained.

Present study result demonstrates a new insight regarding origin of suprarenal arteries, which are not only important for academic interest and also significant in surgical and radiological perspectives [8–11, 13].

## Conclusions

The study result suggests a thorough knowledge of arterial anatomy of suprarenal gland is required for preoperative vascular evaluation and surgical interventions of upper abdominal organs to avoid complications.

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