

Coexistence of multiple arterial variations in the genitourinary system

Seyed Hadi Anjamrooz^{1,*}, Mohammad Mohsen Taghavi², Mehdi Abedinzadeh³, Safiye Mohasel Yazdi¹ and Hassan Azari⁴

¹ Department of Anatomical Sciences, School of Medicine, Kurdistan University of Medical Sciences, Sanandaj, Iran

² Department of Anatomical Sciences, School of Medicine, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

³ Department of Urology, Moradi Hospital, School of Medicine, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

⁴ Department of Anatomical Sciences, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran

Submitted May 17, 2012; accepted October 12, 2012

Summary

Variations in the renal, adrenal and testicular arteries are of clinical significance as well as anatomical and embryological interest. The present case report describes the incidental finding of unilateral multiple renal arteries on the right side with bilateral variant testicular arteries, which had not been reported so far. These variations were observed during routine dissection of the abdominal region in an Iranian cadaver. The upper supplementary renal artery branched from the abdominal aorta and sent superior suprarenal artery to the adrenal gland. The lower supplementary renal artery arose from the main renal artery. Both additional arteries entered the kidney proximal to its hilum. The right testicular artery supplied the right suprarenal gland by an unusual branch. Double testicular arteries were seen on the left side with a relatively high origin from abdominal aorta.

The objective of this report is to supplement the knowledge of vascular variations in the renal, suprarenal and testicular arteries that could be quite useful from a clinical point of view.

Key words

Supplementary renal arteries; suprarenal arteries; testicular arteries; aorta; suprarenal gland.

Introduction

Normally, each kidney is supplied by a single renal artery, which arises from the abdominal aorta at the level of L2. From their origin the arteries run laterally towards the kidney and enter the hilum between renal vein and renal pelvis. The right main renal artery originates below the left renal artery. It has a long downward course due to the inferior position of the right kidney and passes behind the inferior vena cava (Khamanarong et al., 2004; Ozkan et al., 2006).

Testicular arteries usually originate from the abdominal aorta below the origin of the renal arteries at the L2 level. It is a paired artery, with one running obliquely

*Corresponding author. E-mail: Hadi-Anjamrooz@muk.ac.ir; Tel: +98871 6131382; Fax: +98871 6131383.

downwards and laterally under the parietal peritoneum into the pelvic cavity. The testicular artery descends close to the posterior abdominal wall over the psoas major muscle. During its course into the pelvic cavity, it does not normally give off any branches. Each artery passes through the inguinal canal of the corresponding side with the other constituents of the spermatic cord to reach the testis (Onderoglu et al., 1993; Brohi et al., 2001).

The following is a case report describing variations in the renal, suprarenal and testicular arteries as observed in an Iranian male cadaver, which has not been reported so far according to our knowledge. A sound knowledge of the presented arterial variations may be of particular importance to radiologists, urologists, endocrinologists and fertility specialists and could help the clinicians to perform complication-free surgery in this region.

Case report

During a gross anatomy dissection of abdominal region in the cadaver of a 50-years-old Iranian male, certain arterial variations were encountered, which are outlined in Table 1 and Figures 1 and 2.

The main renal arteries branched from the abdominal aorta at the level of intervertebral disc between L1 and L2. They emerged from the aorta about 3 mm below the origin of superior mesenteric artery and 35 mm proximal to origin of inferior mesenteric artery. Both the right and left renal arteries had a normal course. The right middle suprarenal artery emerged from the origin of the main right renal artery. Then, renal artery passed dorsal to inferior vena cava and bifurcated about 38 mm lateral to its origin into upper and lower divisions. The upper division passed laterally and superiorly for approximately 27 mm towards the kidney and ended 15 mm proximal to its hilum. The lower division passed laterally (25 mm long) towards the kidney and ended in the renal hilum by dividing into five branches. These branches passed between renal vein and renal pelvis. The upper pole of the right kidney was also supplied by another accessory artery arising directly from the abdominal aorta at the level of superior mesenteric artery anterior to L1. The length of this upper polar artery was 75 mm, which passed upwards and laterally to reach the right kidney. It then entered the upper part of renal anterior surface near its medial border and ended 33 mm proximal to the hilum. This artery bifurcated 20 mm from its origin and gave a branch (right superior suprarenal artery) that ran superolaterally towards the right adrenal gland into which it

Table 1 – The location and type of the variations of the renal, adrenal and testicular arteries.

| Artery | Side | Type of variation |
|---------------------|------------|--|
| Renal arteries | Right side | Unilateral multiple arteries |
| Suprarenal arteries | Right side | Abnormal origin of superior and inferior suprarenal arteries |
| Testicular arteries | Bilateral | Early branching of the right testicular artery Double testicular arteries on the left side High origin of the left testicular arteries |

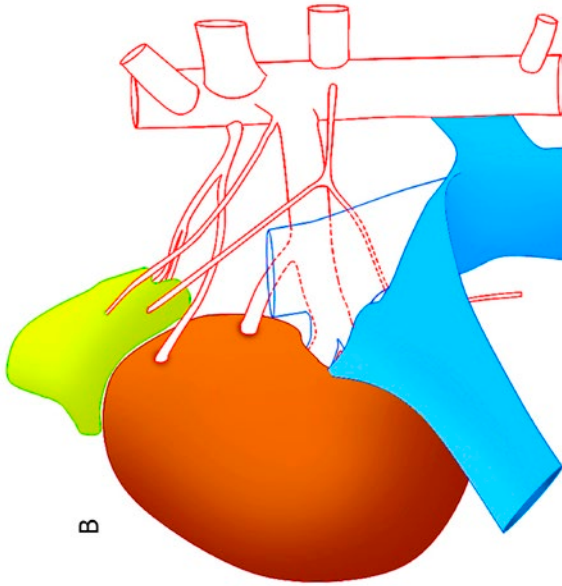
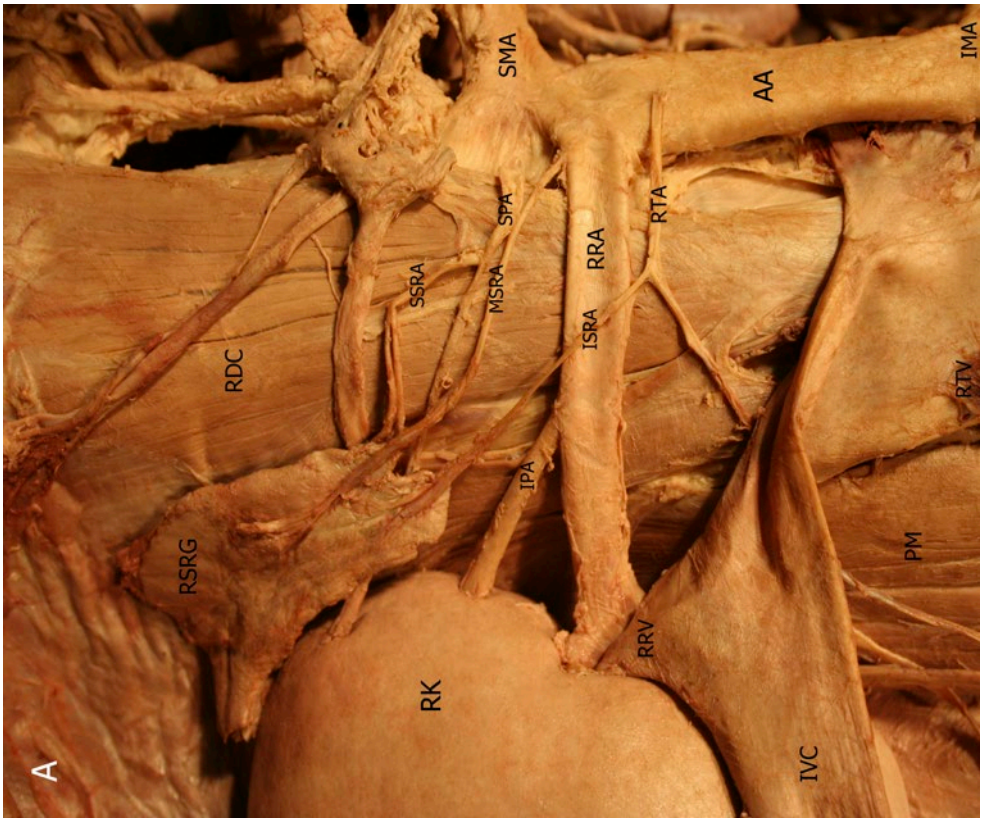


Figure 1 – The arterial variations of the right retroperitoneal space; the inferior vena cava is cut and reflected to show structures behind it. (A) Original image, (B) schematic illustration, RK: right kidney, RSRG: right suprarenal gland, AA: abdominal aorta, IVC: inferior vena cava, RRV: right renal vein, RRA: right renal artery, SMA: superior mesenteric artery, IMA: inferior mesenteric artery, RTA: right testicular artery, RTV: right testicular vein, SSRA: superior suprarenal artery, MSRA: middle suprarenal artery, ISRA: inferior suprarenal artery, SPA: superior polar artery, IPA: inferior polar artery, RDC: right diaphragmatic crus, PM: psoas major.

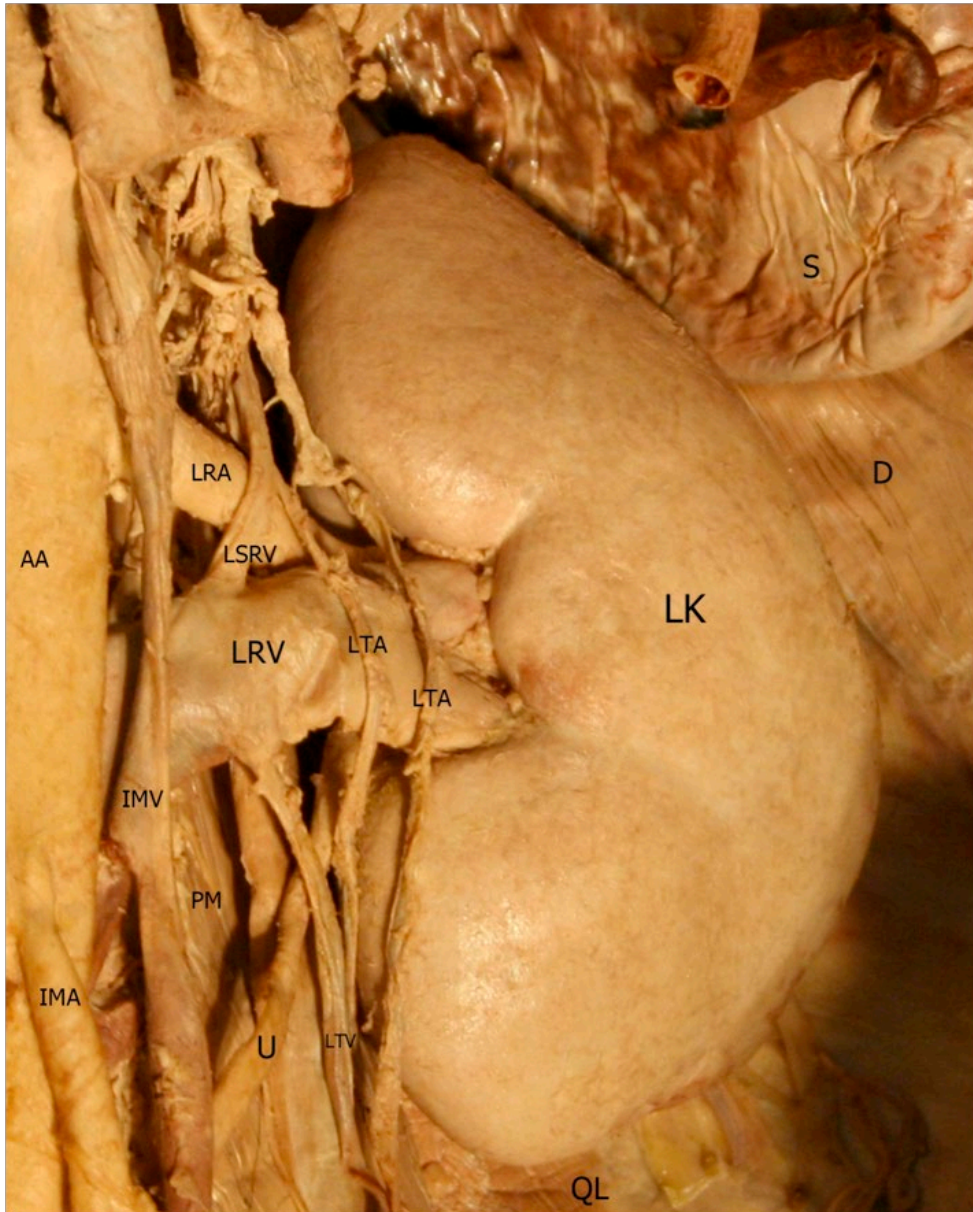


Figure 2 – Retroperitoneal space dissection showing double testicular arteries on the left side, arising higher than usual. They descended inferiorly passing over the left renal vein. S: spleen, LK: left kidney, U: ureter, AA: abdominal aorta, LRV: left renal vein, LRA: left renal artery, IMA: inferior mesenteric artery, IMV: inferior mesenteric vein, LTA: left testicular artery, LTV: left testicular vein, LSRV: left suprarenal vein, D: diaphragm, PM: psoas major, QL: quadratus lumborum.

entered from the gland posterior surface. The renal artery on the left side branched into 2 segmental renal arteries about 40 mm after its origin, which entered the kidney through its hilum. With respect to the abdominal aorta, right main renal artery originated above the left renal artery (Fig. 1).

The right testicular artery arose from the anterior wall of the descending aorta at the level of upper border of L2 vertebra at a right angle. The origin was located about 7 mm below the origin of the ipsilateral renal artery and approximately 28 mm above the origin of the inferior mesenteric artery (Fig. 1).

On further dissection it was found that right testicular artery divided into two branches about 20 mm lateral to its origin. One of them, superior branch, passed laterally and superiorly for approximately 45 mm towards the suprarenal gland. The other, inferior branch, crossed dorsal to the inferior vena cava and descended anterior to the psoas major muscle to the pelvic region (Fig. 1).

On the left side, double testicular arteries (medial and lateral) branched from abdominal aorta. They progressed in an oblique course outwards and caudally, crossing anterior to the left renal vessels. In addition, a bifurcated testicular vein was found which coalesced to form a single vein. The medial testicular artery ran through the space between the two branches of the bifurcated left testicular vein. The double testicular arteries on the left side had higher origin than usual, however, the rest of their course was normal (Fig. 2).

Along with these arterial variations, abnormal patterns of the renal veins, muscular and hepatobiliary anomalies were also found and some of these data have been published elsewhere (Anjamrooz *et al.*, 2012; Anjamrooz and Azari, 2012; Anjamrooz, 2013).

Discussion

Supplementary renal arteries in the present case show similarities to the cases in the other studies, but there are also some interesting differences.

Rusu (2006) observed bilateral supernumerary renal arteries arising from the aorta. Jetti *et al.* (2008) described an accessory renal artery originating from the left common iliac artery.

In another study of renal arterial variations conducted on 534 kidneys, triple renal arteries occurred in five of cases (Khamanarong *et al.*, 2004). Right kidney with three arteries also was reported by Loukas *et al.* (2005) and Nayak (2008). However, presence of double polar arteries, with different origins, was not reported in these studies.

In the present case, superior accessory renal artery was bifurcated to supply the kidney and the suprarenal gland. In Nayak's report (2008), the superior renal artery was trifurcated before entering the kidney. In addition, in this case, inferior suprarenal artery branched from the right testicular artery. Brohi *et al.* (2001) described an unusual similar case, but on the left side.

In our case, the left renal artery was normal and variations were observed on the right side, while in general the additional renal arteries are more frequent on the left side (Khamanarong *et al.*, 2004; Jetti *et al.*, 2008; Singh *et al.*, 1998), which adds another interesting aspect to the present vascular variations.

There have been several cases reported over the last few years on the high origin of the gonadal arteries. Brohi *et al.* (2001) found a high-origin testicular artery on the

left side, which originated from the left renal artery. The most highly positioned testicular artery ever documented was a left testicular artery that originated from the aorta 10 mm cranial to the origin of the inferior phrenic artery (Shinohara et al., 1990).

The high origin of the left testicular artery in the present case is unique in that it occurred along with accessory testicular artery on the left side. In addition, on the right side, the inferior suprarenal artery arose from the testicular artery.

Classically, testicular artery arises at an acute angle from the abdominal aorta, but in present case it originated at a right angle on the right side.

Normally, the inferior suprarenal artery is provided by the renal artery (Nayak, 2008), whereas we observed that the right inferior suprarenal artery originated from a common trunk with the right testicular artery. Paraskevas et al. (2011) reported similar pattern, but on the left side. Although anatomical variations of the middle suprarenal artery are common, reports on variations of the superior and inferior suprarenal arteries are rare.

In comparison to our case, Onderoglu et al. (1993) reported the right testicular artery giving rise to the inferior phrenic and the superior suprarenal arteries. Loukas et al. (2005) observed that the left testicular artery branched from a common trunk with left renal artery. Singh et al. (1998) reported a case of bilateral common trunk that splitted into the accessory renal artery and gonadal artery.

In 1956, Notkovitch reported that in 22% of the cases studied the testicular arteries descended into the pelvis crossing anterior to the renal vein and posterior to the inferior vena cava. Testicular arteries in our case passed posterior to the inferior vena cava on the right side and crossed anterior to the renal vein on the left side.

Notkovitch classified the patterns of relationship between renal vein and testicular artery into three principal types: type 1: testicular artery originating from the aorta, passing inferior or posterior to the renal vein but without making contact with it; type 2: testicular artery arising from the aorta above the renal vein and crossing anterior to it; type 3: lower origin of the testicular artery than the renal vein – the testicular artery arching around the renal vein.

In present case, on the left side, double testicular arteries were observed with a high aortic origin (above the left renal vein), and crossed anterior to the renal vein, similar to type 2. On the right side, the testicular artery passed posterior to the renal vein but without making contact with it, which is classified as type 1.

Some of the variations that are reported here may have already been reported as individual cases of variations, but occurrence of vascular variations of the kidney, suprarenal gland and testis in the same individual have not been reported till date. Therefore, the comprehensive knowledge of the presented arterial pattern remains as the key issue in determining the technical feasibility of surgical interventions as well as the post operative management.

Embryological basis

Present variations can be explained by the embryological development pattern of the kidney, adrenal and gonad from the intermediate mesoderm and the vascular supply of these organs from the lateral mesonephric branches of the dorsal aorta (Benedetti et al., 1995).

The kidneys begin their development in the pelvic cavity and then ascend from the pelvis to their final position in the lumbar region. As the kidneys ascend, they receive their blood supply from vessels that are close to them and the caudal branches suffer major atrophy (Ravery *et al.*, 1993). In the present case, though kidneys were situated in the lumbar region, the right kidney was supplied by two accessory renal arteries. It is possible that the kidney has been assumed an abnormal higher position at first, and then descended for a short distance. Hence the failure in the disappearance of the blood vessels that supplied the kidney when it was located in a higher position resulted in the observed additional renal arteries.

Any of the mesonephric arteries can develop to become the testicular artery, but they derive usually from the caudal group and rarely from the middle or cranial group (Felix, 1912). It may be suggested that, in this case, the testicular arteries on the right and left side evolved from the middle and cranial groups, respectively. The persistence of several mesonephric arteries may result in additional testicular arteries (Kitamura *et al.*, 1987), similar to what was seen in present case.

Felix (1912) reported that when the testicular artery derives from the cranial group of mesonephric arteries, it passes posterior to the renal artery; however in present case testicular arteries passed anterior to the renal artery. This means that the cranial, middle and caudal groups are not independent of each other but connected by longitudinal anastomotic channels, which located anterior to the developing renal artery.

References

- Anjamrooz S.H. (2013) Biceps sternalis: a Y-shaped muscle on the anterior chest wall. *J. Cardiothorac. Surg.* 8: 38.
- Anjamrooz S.H., Azari H. (2012) Coexistence of multiple anomalies in the hepatobiliary system. *Anat. Cell Biol.* 45: 62-65.
- Anjamrooz S.H., Azari H., Abedinzadeh M. (2012) Abnormal patterns of the renal veins. *Anat. Cell Biol.* 45: 57-61.
- Benedetti E., Troppmann C., Gillingham K., Sutherland D.E., Payne W.D., Dunn D.L., Matas A.J., Najarian J.S., Grussner R.W. (1995) Short- and long-term outcomes of kidney transplants with multiple renal arteries. *Ann. Surg.* 221: 406-414.
- Brohi R.A., Sargon M.F., Yener N. (2001) High origin and unusual suprarenal branch of a testicular artery. *Surg. Radiol. Anat.* 23: 207-208.
- Felix W. (1912) Mesonephric arteries. In: Keibel F., Mall F.P. (eds): *Manual of Human Embryology*, Vol. 2, Lippincott, Philadelphia-London. Pp 820-825.
- Jetti R., Jevoor P., Vollala V.R., Potu B.K., Ravishankar M., Virupaxi R. (2008) Multiple variations of the urogenital vascular system in a single cadaver: a case report. *Cases J.* 1: 344.
- Khamanarong K., Prachaney P., Utraravichien A., Tong-Un T., Sripaoraya K. (2004) Anatomy of renal arterial supply. *Clin. Anat.* 17: 334-336.
- Kitamura S., Nishiguchi T., Sakai A., Kumamoto K. (1987) Rare case of the inferior mesenteric artery arising from the superior mesenteric artery. *Anat. Rec.* 217: 99-102.
- Loukas M., Aparicio S., Beck A., Calderon R., Kennedy M. (2005) Rare case of right accessory renal artery originating as a common trunk with the inferior mesenteric artery: a case report. *Clin. Anat.* 18: 530-535.

- Manso J.C., DiDio L.J. (2000) Anatomical variations of the human suprarenal arteries. *Ann. Anat.* 182: 483–488.
- Nayak B.S. (2008) Multiple variations of the right renal vessels. *Singapore Med. J.* 49: 153-155.
- Notkovich H. (1956) Variations of the testicular and ovarian arteries in relation to the renal pedicle. *Surg. Gynecol. Obstet.* 103: 487–495.
- Onderoglu S., Yuksel M., Arik Z. (1993) Unusual branching and course of the testicular artery. *Anat. Anz.* 175: 541–544.
- Ozkan U., Oğuzkurt L., Tercan F., Kizilkiliç O., Koç Z., Koca N. (2006) Renal artery origins and variations: angiographic evaluation of 855 consecutive patients. *Diagn. Interv. Radiol.* 12: 183-186.
- Paraskevas G.K., Ioannidis O., Raikos A., Papaziogas B., Natsis K., Spyridakis I., Kitsoulis P. (2011) High origin of a testicular artery: a case report and review of the literature. *J. Med. Case Rep.* 5: 75.
- Ravery V., Cussenot O., Desgrandchamps F., Teillac P., Martin-Bouyer Y., Lassau J.P., Le Duc A. (1993) Variations in arterial blood supply and the risk of hemorrhage during percutaneous treatment of lesions of the pelviureteral junction obstruction: report of a case of testicular artery arising from an inferior polar renal artery. *Surg. Radiol. Anat.* 15: 355-359.
- Rusu M.C. (2006) Human bilateral doubled renal and testicular arteries with a left testicular arterial arch around the left renal vein. *Rom. J. Morphol. Embryol.* 47: 197-200.
- Shinohara H., Nakatani T., Fukuo Y., Morisawa S., Matsuda T. (1990) Case with a high-positioned origin of the testicular artery. *Anat. Rec.* 226: 264–266.
- Singh G., Ng Y.K., Bay B.H. (1998) Bilateral accessory renal arteries associated with some anomalies of the ovarian arteries: a case study. *Clin. Anat.* 11: 417-420.