

CASE REPORT

Multiple anomalies involving testicular and suprarenal arteries: embryological basis and clinical significance

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Abstract

Variations in the origin of arteries in the abdomen are very common but with the invention of new operative techniques within the abdominal cavity, the anatomy of abdominal vessels has assumed much more clinical importance. During routine dissection of the abdominal cavity, we came across multiple arterial anomalies involving testicular and suprarenal arteries. On the right side, there was double testicular artery (medial and lateral) and the right inferior suprarenal artery arose from the medial testicular artery. The right inferior phrenic artery (IPA) and middle suprarenal artery took origin from a common trunk just above the origin of right renal artery (RRA). On the left side, the left testicular artery was arching over the lower tributary of the left renal vein proper (LRVP). Apart from the developmental and morphological interest in arching gonadal arteries, they are of practical importance from a clinical and surgical viewpoint. The embryological and clinical significance of above variations has been described.

Keywords: anomalies, testicular artery, suprarenal artery.

Introduction

The testicular arteries are paired vessels that usually arise from the abdominal aorta at the second lumbar vertebral level. Each artery passes obliquely downwards and posterior to the peritoneum. Descending on the posterior abdominal wall, each reaches the deep inguinal ring where it enters the spermatic cord (Hollinshead WH, 1971) [1].

However, they may also originate from the renal artery, middle suprarenal artery, one of the lumbar arteries, common or internal iliac artery, or the superior epigastric artery. In the abdomen, the testicular artery supplies the perirenal fat, ureter and external iliac lymph nodes; in the inguinal canal, it supplies the cremaster muscle (Hollinshead WH, 1971; Bergman RA *et al.*, 1988; Williams PL *et al.*, 1989; Anson BJ, 1996; Machnicki A and Grzybiak M, 1997; Moore KL and Dalley AF, 1999) [1–6].

Notkovich H (1956) examined the testicular and ovarian arteries, and described three different patterns in relation to the renal vein: in the first group, the testicular artery originating from abdominal aorta had no relation to the renal vein; in the second, the testicular artery originated at a level superior to the renal vein and descended anterior to it; and in the third type it originated at the same level or at a point inferior to the renal vein.

The third type is also called the arched testicular artery (of Luschka) because it passes, in succession, posterior, superior, and anterior to the renal vein [7]. The frequency of third type of artery has been reported as 6% (Notkovich H, 1956) [7] and

22% (Kamina P, 1974) [8]. This type of relationship was found on the left side of the present variation.

The testicular arteries may vary at their origin. They may be missing, or one or both arteries may arise from the renal artery, suprarenal artery, or lumbar artery. Also, they may arise from a common trunk or be doubled, tripled, or quadrupled (Bergman RA *et al.*, 1992) [9].

Testicular artery variation has been described by various authors (Otulakowski B and Woźniak W, 1975; Shinohara H *et al.*, 1990; Bergman RA *et al.*, 1992; Ravery V *et al.*, 1993; Ozan H *et al.*, 1995; Brohi RA *et al.*, 2001; Loukas M and Stewart D, 2004; Xue HG *et al.*, 2005; Kocabiyik N *et al.*, 2005; Rusu MC, 2006; Deepthinath R *et al.*, 2006; Shoja MM *et al.*, 2006) [9–20].

Arching of gonadal artery above the renal vein has been described by the past and recent authors (Notkovich H, 1956; Rusu MC, 2006; Nathan H *et al.*, 1976; Grine FE and Kramer B, 1981; Naito M *et al.*, 2006) [7, 18, 21–23]. Similarly, variations in the origin of suprarenal arteries have been described in the literature (Shinohara H *et al.*, 1990; Brohi RA *et al.*, 2001; Onderoglu S *et al.*, 1993; Bhaskar PV *et al.*, 2006) [11, 14, 24, 25].

Material and methods

During routine dissection of the abdominal cavity of a 64-year-old male cadaver, we observed bilateral testicular artery variation with anomalies in the origin of the supra renal and inferior phrenic artery in the right side.

☐ Results

On the left side (Figures 1 and 3), the left testicular artery (LTA) arose below the origin of the left renal artery (LRA) and was arching over the upper tributary of LRVP and coursed with the left testicular vein (LTV), medially to the left kidney. The LTA followed the LTV over the psoas major muscle and the external iliac artery to enter the inguinal canal.

On the right side (Figures 2 and 3) multiple variants were also found (i) the pre hilar branching of RRA into two, upper branch ran above and the lower branch ran below the right renal vein (RRV) on its way to the renal hilum was seen; (ii) superior polar artery (SPA) was aroused from the upper pre hilar RRA. (ii) There were double right testicular arteries; the lateral testicular artery arose from the upper pre hilar RRA and coursed over the anterior surface of the right kidney and the medial testicular artery, emerged on the anterior side of the abdominal aorta, 1.3 cm below the origin of the RRA and under the LRVP, then coursed below the inferior vena cava to join the right testicular vein (RTV).

Some other additional anatomical variants were also found (iii) the inferior supra renal artery took origin from the medial testicular artery; (iv) a common trunk gave rise to the inferior phrenic artery (IPA) and middle suprarenal artery just above the origin of RRA.

The superior suprarenal artery took origin from the IPA as expected.

☐ Discussions

Variations in the origin, course, and branches of the testicular arteries are attributed to their embryological origin (Bhaskar PV *et al.*, 2006) [25]. The first note on the embryological origin of the gonadal artery was made by Felix W (1912) [26].

The embryo has three sets of lateral mesonephric arteries namely cranial, middle, and caudal. One of the caudal arteries usually persists and differentiates into the definitive gonadal artery. However, the persistence of a cranial lateral mesonephric artery may result in a high-origin of the gonadal artery (Felix W, 1912) [26].

Çiçekcibaşı AE *et al.* (2002) revealed that the middle group of lateral mesonephric arteries gave rise to a gonadal artery that originated from the renal artery, while that of the cranial group gave rise to a gonadal artery that originated from the suprarenal artery or from a more superior aortic level [27].

In the present case, the lateral testicular artery may have developed from the middle group of lateral mesonephric arteries and medial testicular artery may have developed from the cranial group of lateral mesonephric arteries.

During embryological development, the lateral splanchnic branches of the dorsal aorta, on each side, supply the mesonephros and metanephros kidneys, the gonads, and the suprarenal glands. These structures develop partly or completely from intermediate mesoderm.

Usually, one gonadal and three suprarenal arteries persist on each side of the abdominal aorta. The lateral

splanchnic branches of the dorsal aorta persist as testicular arteries. They enter the mesonephros crossing ventral to the supracardinal vein and dorsal to the subcardinal vein. Normally, the lateral splanchnic artery that persists as the right testicular artery passes anterior to the supracardinal anastomosis, which gives rise to part of the inferior vena cava.

When it coursed posterior to this anastomosis in the embryo, the right testicular artery courses posterior to the inferior vena cava in the adult (Williams PL *et al.*, 1995; Moore KL, 1998) [28, 29]. This above embryological basis may describe why the medial testicular artery coursed posterior to the inferior vena cava in the present case.

Naito M *et al.*, 2006 mentioned that compression of the LRV between the abdominal aorta and the superior mesenteric artery occasionally induces LRV hypertension, resulting in varicocele, orthostatic proteinuria and hematuria [23].

Considering that the incidence of a left arching testicular artery is higher than that of a right one, an arching left artery could be an additional cause of LRV hypertension. Compression of the left renal vein (LRV) between the aorta and the superior mesenteric artery has been termed the nutcracker syndrome; obstruction of LRV outflow results in venous hypertension with the formation of intra and extra renal collaterals and/or the development of gonadal vein reflux (Rudloff U *et al.*, 2006) [30].

Anomalous origin of the testicular artery from the inferior polar artery of the kidney and its surgical importance has been reported by Ravery *et al.* (1993) [12].

Otulakowski B and Woźniak W (1975) found an aberrant testicular artery that originated from the main renal artery and passed posterior to the inferior vena cava [10].

Depthinath R *et al.* (2006) reported a double left testicular artery, one originated from an accessory renal artery and the other from the main renal artery [19].

The origin of the inferior phrenic and suprarenal arteries from a high-origin testicular artery has also been described in literature (Shinohara H *et al.*, 1990; Brohi RA *et al.*, 2001) [11, 14].

Naito M *et al.*, 2006 described two cases of the left testicular artery arching over the ipsilateral renal vein, similar to our finding [23]. Nathan H *et al.*, 1976 described a case where both the right and left testicular arteries arching over the left renal vein [21].

Rusu MC (2006) described a case of bilateral doubled testicular arteries with a left testicular arterial arch around the left renal vein, much similar to our variation [18].

Rarely the inferior suprarenal artery may originate from the genital artery or, also very rarely, from the celiac trunk (Bordei P *et al.*, 2003) [31].

In a Turkish male, the right testicular artery was found to originate from the aorta at nearly the same level as and anterior to the renal artery. This testicular artery was seen to give off the inferior phrenic and superior suprarenal arteries and was coursed below the inferior vena cava (Onderoglu S *et al.*, 2003) [24].

Figure 1 – Left retroperitoneal space dissection, anterior view: AA – abdominal aorta; IVC – inferior vena cava; IM – inferior mesenteric artery; L – lower tributary of left the renal vein proper; U – upper tributary of the left renal vein proper; LRVP – left renal vein proper; LTV – left testicular vein; Lsv – left suprarenal vein; LSG – left suprarenal gland; LRA – left renal artery; LK – left kidney; PM – psoas major; ut – left ureter; Ata – arterial arcade of large intestine. Note the arrows (left testicular artery) arching over the lower tributary of left renal vein proper

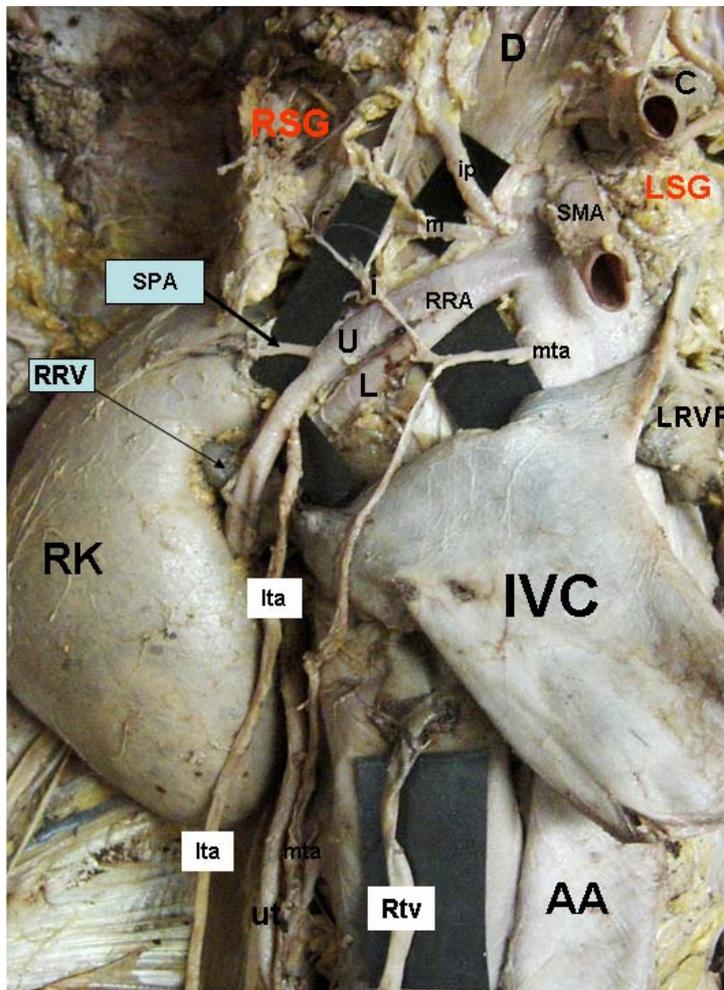
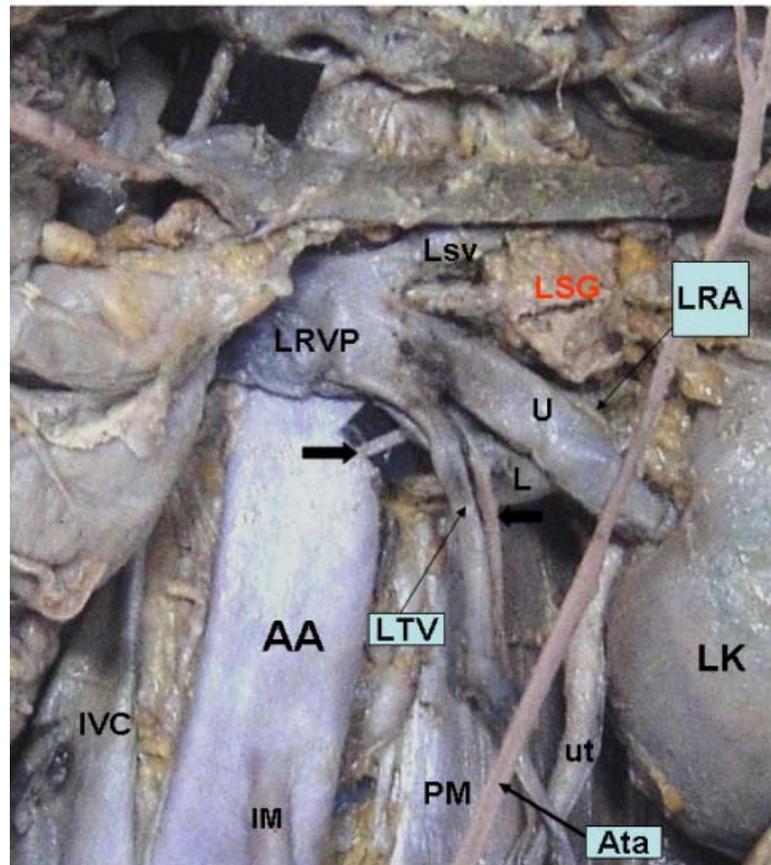


Figure 2 – Right retroperitoneal space dissection, anterior view: AA – abdominal aorta; IVC – inferior vena cava; LK – left kidney; LRVP – left renal vein proper; U – upper pre hilar division of the right renal artery; L – lower pre hilar division of the right renal artery; RSG – right suprarenal gland; LSG – left suprarenal gland; RRA – right renal artery; RRV – right renal vein; SMA – superior mesenteric artery; C – coeliac trunk; D – diaphragm; SPA – superior polar artery; mta – medial testicular artery; lta – lateral testicular artery, taking origin from the upper pre hilar division of the right renal artery; ut – right ureter; Rtv – right testicular vein; i – inferior suprarenal artery, taking origin from the medial testicular artery; m – middle suprarenal artery; ip – inferior phrenic artery

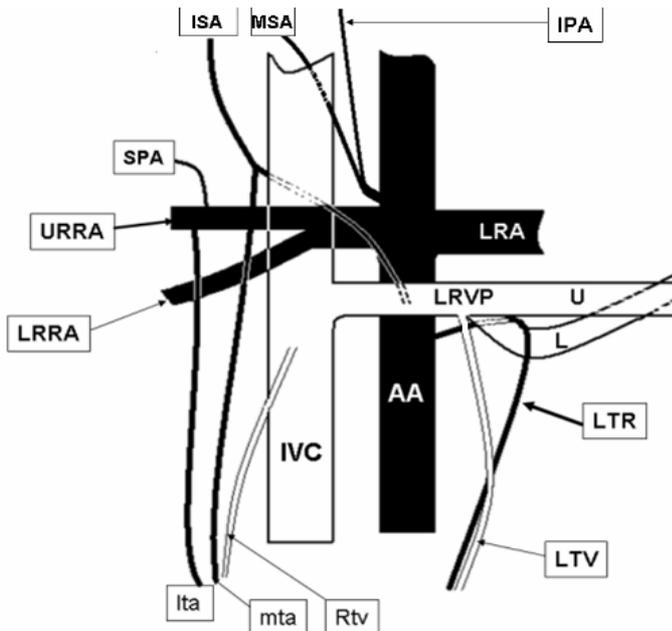


Figure 3 – Schematic diagram of Figures 1 and 2: AA – abdominal aorta; IVC – inferior vena cava; URRA – upper pre hilar division of the right renal artery; LRRA – lower pre hilar division of the right renal artery; RRV – right renal vein; SPA – superior polar artery; ISA – inferior suprarenal artery; MSA – middle suprarenal artery; Ita – lateral testicular artery; mta – medial testicular artery; Rtv – right testicular vein; LTV – left testicular vein; LRVp – left renal vein proper; U – upper tributary of left renal vein proper; L – lower tributary of left renal vein proper; LTR – left testicular artery; IPA – inferior phrenic artery

Bhaskar PV *et al.* (2006) described a case of testicular artery variation in which, they mentioned the testicular artery arose from the anterior surface of the abdominal aorta and immediately divided into two branches; one branch coursed inferiorly behind the inferior vena cava as the testicular artery proper, while the other branch passed behind the inferior vena cava and bifurcated into an ascending branch that went to the right suprarenal gland and a descending branch that ended in the posterior abdominal wall [25].

Tanabe N *et al.* (1998) and Gokan T *et al.* (2001) mentioned that, the right IPA was always associated with hepatocellular carcinoma (HCC) and served as the major collateral artery adjunct to the hepatic artery, so its important to know the IPA variability in its origin and course [32, 33].

Variations in the gonadal vessels may influence the blood flow to the kidney and gonadal glands and cause some pathological conditions as varicocele (Notkovich H, 1956) [7].

With the advancement of new operative techniques within the abdominal cavity, the anatomy of gonadal vessels has assumed much more importance. The gonadal vessels must be preserved to avoid the possible complications following damage of these vessels. During laparoscopic surgery of the male abdomen and pelvis, many complications may arise, due to unfamiliar anatomy in the operative field (Cussenot O *et al.*, 1993) [34].

The variations which are reported here, have already been reported as individual cases of variations but occurrence of variations of the testicular, renal, suprarenal, inferior phrenic arteries in the same person have not been reported in literature to the best of our knowledge.

☒ Conclusions

The awareness of such arterial variations, in relation to the renal, testicular, suprarenal and inferior phrenic arteries could be of paramount importance to the

vascular surgeons and urologist and oncologist, during surgery in the retroperitoneal region.

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