A Cadaveric Study about the Anomalous Origin of Testicular Arteries Arising from the Accessory Renal Arteries

Mamatha H. · Antony Sylvan D'Souza · Vinodhini P. ·
Biswabina Ray · Suhani · Pallavi

Received: 30 May 2012 / Accepted: 10 September 2012 / Published online: 30 October 2012
© Association of Surgeons of India 2012

Abstract Testicular arteries are paired vessels, arising from the abdominal aorta, at the level of second lumbar vertebra. Variations in the origin of these vessels highlight a potential importance regarding the vascular supply to the gonads and kidneys. This study was designed to assess the variations in the origin, course, and distance about the point of origin of the testicular arteries. The posterior abdominal walls of 40 male cadavers were studied on either side, during routine dissection in the Department of Anatomy, Kasturba Medical College, Manipal. A majority had a normal course and the variations were reported as: a) Bilateral origin of gonadal arteries from accessory renal arteries, b) Unilateral origin of the gonadal artery from the left accessory renal artery, and c) Unique origin of the right testicular artery from the right inferior epigastric artery and left testicular artery from descending thoracic aorta above the aortic opening of the diaphragm. Due to the embryological attribution, these variations in the testicular arteries indicate an alarming threat to the radiologists and surgeons during renal transplants and nephrectomies, as these vessels monopolize the vascular supply to the gonads. This study was undertaken to document the incidence of testicular arteries originating from accessory renal arteries.

Keywords Testicular artery · Accessory renal artery · Renal transplant · Variations

Introduction

The testicular artery originates from the anterolateral surface of the abdominal aorta, below the level of origin of the renal arteries, usually at the level of the second lumbar vertebra. Each testicular artery passes obliquely downward along with the corresponding vein and posterior to the peritoneum on the psoas major muscle. It enters the inguinal canal through the deep inguinal ring, reaches the gonads to supply the testis, and accompanied by the pampiniform plexus of veins in the scrotum. Along their course in the abdomen, the testicular arteries are accompanied by the testicular veins [1, 2].

Rarely, the origin of the testicular artery may be from the renal artery or from other arterial sources, such as middle suprarenal artery, lumbar artery, common or internal iliac artery, inferior epigastric artery. The anomalies can be explained by the embryological development of both the kidney from the intermediate mesoderm of the mesonephric crest, and vascularization of both the kidneys and gonads from the lateral mesonephric branches of the dorsal aorta [3].

The vertebral level of origin of the testicular arteries varies from the first to third lumbar level. Variations related to origin, course and number of the renal and testicular arteries have been reported. The testis mainly receives its blood supply from the testicular artery and drains into the testicular vein. Testicular vessels have an important role in testis thermoregulation. Variations of these arteries and veins have been extensively studied pertaining to their importance in testicular physiology [4].

The vascular and developmental anomalies of the kidneys can be associated with variations in the course of the testicular arteries [5].

M. H. (✉) · A. S. D'Souza · V. P. · B. Ray · Suhani · Pallavi
Department of Anatomy, Kasturba Medical College,
Manipal University,
Manipal 576104 Karnataka, India
e-mail: mamatha2010@yahoo.com

The anatomical variations of testicular arteries are of clinical importance as well as embryological and anatomical interest. In the present study, we analyzed the origin, course and distance assessment about the point of origin of the testicular arteries and highlighted the embryological variations and their clinical concerns.

Materials and Methods

During routine dissection in the Department of Anatomy, Kasturba Medical College, Manipal, the posterior abdominal walls of 40-male cadavers were studied on either sides during the academic period from 2008 and February 2010. Retroperitoneal structures were exposed after the routine dissection of the abdominal cavity.

The connective tissues around the renal and testicular arteries were removed for a good clarity of vision. Observations of the origin and course of the testicular arteries were noted.

Two kinds of studies were carried out.

- I) Variations in the origin of testicular arteries.
- II) Tabulation of the distance assessment about the point of origin of the testicular artery from the accessory renal artery taking aortic bifurcation into consideration. The aforesaid data was collected and interpreted with the other sources cited in the literature.

Results

We found that in 80 % of the cases, the testicular arteries were normal in their origin, course and number, as cited in standard anatomical text books. However, in the rest of 20 % cases, variations in the testicular arteries were noticed.

- I) The following arterial variations were found to coexist with multiple accessory renal arteries.
 - VARIATION 1: The testicular artery on the right side had a normal pattern of origin and course, whereas it arose from the accessory renal artery on the left side. It traveled in front of the left ureter and followed a normal course (Fig. 1).
 - VARIATION 2: The left testicular artery arose from the accessory renal artery, before the origin of the superior renal capsular branch from the accessory renal artery, and descended down toward the deep inguinal ring. The right testicular artery exhibited a normal course (Fig. 2).
 - VARIATION 3: The right testicular artery arose from the renal accessory artery before it bifurcated. The left testicular artery arose from the accessory

Fig. 1 Origin of left testicular artery arising from accessory renal artery. *K* kidney, *AA* abdominal aorta, *IVC* inferior vena cava, *RTA* right testicular artery, *LTA* left testicular artery, *U* ureter, * left testicular vein, *ARA* accessory renal artery

Fig. 2 Photograph of the variation in the left testicular artery. *AA* abdominal aorta, *RTA* right testicular artery, *LTA* left testicular artery, *LTV* left testicular vein, *IMA** inferior mesenteric artery

renal artery. Later both followed a normal course (Fig. 3).

- VARIATION 4: The left testicular artery arose from the accessory renal artery crossed the ureter as it descended and passed laterally toward the inguinal canal. The right testicular artery had a usual course (Fig. 4).
- VARIATION 5: The right testicular artery arose from the right inferior epigastric artery, traveled downward to reach the deep inguinal ring and further their termination was as usual (Fig. 5). The left testicular artery arose from the descending thoracic aorta above the aortic opening of the diaphragm

Fig. 3 Photograph of the variation of testicular arteries on both the sides. AA abdominal aorta, IVC inferior vena cava, U ureter, RTA right testicular artery, LTA left testicular artery, * accessory renal artery

Fig. 4 Photograph of the left testicular artery arising from the accessory renal artery. AA abdominal aorta, ARA accessory renal artery, RTA right testicular artery, LTA left testicular artery, * IMA inferior mesenteric artery

above the level of T12, later descended down along with testicular veins and left ureter and had a normal course to the gonads (Fig. 6).

- II) Distance assessment about the point of origin of the testicular artery from the accessory renal artery taking aortic bifurcation into consideration is shown in Table 1.

Discussion

A wide range of variability is seen in the origin, length, course and calibrity of the testicular arteries. Many authors have reported about the anomalous origin of the testicular arteries. The surgical importance of testicular arteries seems to be the prime consideration during the interventional therapies for varicocele and undescended testis. According to Hollinshead, the origin of the testicular artery from the inferior epigastric artery is a unique and very rare variation. These variations create subtle awareness for the surgeons during surgical managements in order to take meticulous precautions. If one of the lateral mesonephric arteries, in

Fig. 5 Photograph of an unique origin of right testicular artery arising from the right inferior epigastric artery and left testicular artery arising from the descending thoracic aorta above the diaphragmatic opening. AA abdominal aorta, RTA right testicular artery, RTV right testicular vein, LTA left testicular artery. 1 inferior epigastric artery, 2 cremasteric branch of the testicular artery

Fig. 6 Cross section of the cadaver at the level of aortic opening of the diaphragm for the museum specimen preparation. DTA descending thoracic aorta, LTA left testicular artery, LG left lung

addition to the main renal artery persists, it results in the origin of accessory renal artery [1, 2].

According to Felix, nine lateral mesonephric arteries are divided into cranial, middle and caudal groups. The caudal arteries give rise to gonadal arteries. The middle group of lateral mesonephric arteries gives rise to the renal arteries. The persistence of additional such arteries gives rise to ARA. We present two cases here in which the cranial and caudal groups of lateral mesonephric arteries persisted and caused an associated variation of the renal and testicular arteries. A higher level of the origin denotes the original position of the gonads before the caudal migration (Fig. 7) [2, 3].

The presence of a testicular artery originated from the accessory renal artery may lead to its injury during the percutaneous treatment of the syndrome of the pelvilinear junction, becoming a major contraindication. Such an arterial injury follows a massive bleeding that imposes hemostasis by embolization. Various disappearing phases of the lateral mesonephric arteries and their longitudinal anastomotic channels take place during the embryonic development of the gonads. These modifications can lead to variations in the origin of suprarenal, renal and testicular arteries [3, 4].

In one case, we found the testicular and renal capsular arteries arose from a common trunk on the left side, similar to the findings of Pai et al. It is known that genetics, various chemical agents, growth and transcription factors, and hemodynamic forces take part in the selection and persistence of a particular congenital vascular channel. However, the particular embryonic signals that result in the formation of an accessory renal artery or aberrant gonadal artery are yet unknown. The surgeons should take into account the aberrant origin and course of the gonadal arteries when operating near a renal pedicle or in the retroperitoneum [5].

Retroperitoneal approach provides a better solution. It signifies the importance of the arteriography or Doppler ultrasound examination of the renal hilum, prior to any surgical procedures. Our findings agree with reports of the testicular artery arising from the renal accessory artery reported by Ravary et al. [6, 7].

Our findings of the bilateral origin of testicular arteries originating from ARA are similar to the findings of Lippert et al. However, the unilateral origin of testicular arteries is frequently seen. Bilateral variations of the origin as such are rare, whereas we found such a variation in our present study [6–8].

Though the anatomical features of the testicular vessels are relatively constant, occasional developmental and anatomical variations have been reported. According to Asala et al, and Cicekcibasi et al a majority of the testicular arteries arose from the right renal artery [9, 10].

Specimen no	Vertebral level of origin (R)	Vertebral level of origin (L)	Vertical extent (R)CM	Vertical extent (L)CM	Horizontal extent (R)CM	Horizontal extent (L)CM
1	L2	L2	8.8	10.8	—	3.1
2	L2	L2	—	8.7	—	3.5
3	L2	L2	8.4	8.2	2.9	3.5
4	L2	L2	7.5	7.9	—	3.2

Horizontal extent=from the point of origin of accessory renal artery to origin of testicular artery

With the knowledge about the point of origin of the testicular artery arising from the accessory renal artery, it creates a clinching awareness and paramount significance for the interventional radiologists and nephrologists to consider the above cited measurements for these variations. It may aid in preventing iatrogenic ischemic and testicular atrophy [13].

Postoperative minor complications following the renal transplant surgeries may lead to epididymitis, testicular swellings, testicular infarction, renal artery stenosis, renal artery thrombosis, etc., which are life threatening to the patients and therapeutically compromise such surgical procedures [14, 15].

It is reported that transplanted kidneys presenting anatomic vascular variations are associated with a drastic failure rate compared to the kidneys with a single artery, and kidneys with accessory renal vessels have the highest failure rate due to renal vascular thrombosis. However, to overcome the increasing demand for kidney transplantation, living donor grafts have become a major source to maintain the donor pool, and an allograft with multiple arteries has become a necessity, so the knowledge of such variations has become even more important [16].

A detailed anatomical diagram of the mesonephros and associated structures. The central feature is the mesonephros, which is divided into a central 'SUPRARENAL BODY' and two lateral 'SUPRARENAL GLAND' regions. The mesonephros is surrounded by the 'MESONEPHROS' tissue. The diagram shows the 'META-NEPHROS' and 'RETE ARTERIOSUM UROGENITALE' (RAU) on both sides. The RAU is a network of blood vessels that branches out to supply the mesonephros and the surrounding tissues. The diagram is labeled with various numbers (1-12) indicating specific anatomical features and structures.

Conclusion

A higher frequency of the left testicular variations may determine some authors to suggest that the right kidney as the preferred choice for the renal transplant. Variations in the origin of testicular arteries may cause varicocele due to testicular vein compression, hydronephrosis, occlusion of the ureter, nephroptosis, arterial hypertension produced by renal arterial constriction and incidences of kidney infarction during urologic and oncological interventions.

Anatomical knowledge of the origin and course of the testicular artery is of great importance during renal and testicular surgery. It is important to be aware that accessory renal arteries are end arteries. Therefore, if an accessory artery is damaged, the part of the kidney supplied by it becomes ischemic. The origin and course of the testicular artery must be carefully identified and demarcated in order to preserve and prevent testicular atrophy. Beside from surgical interest, the trait is of clinical value because anomalies in arterial and venous perfusion may have severe consequences for the thermoregulation of the testicular glands and hence influence spermiogenesis.

With the increasing demand for kidney transplantation, living donor grafts have become the major source for maintaining the donor pool, and the successful allograft with multiple arteries has become a necessity. Multiple renal arteries can present a challenge during live laparoscopic donor nephrectomy procedures.

Due to the embryological attribution, these variations in the testicular arteries indicate an alarming threat to the radiologists and surgeons during renal transplants, total or partial nephrectomies, as these vessels monopolize the vascular supply to the gonads. This study was undertaken to document the incidence of testicular arteries originating from accessory renal arteries. A meticulous observation of the vascular patency and prevention of testicular atrophy are desirable to avoid life-threatening complications.

In our consideration, it is crucial for surgeons to explore the knowledge of such possibilities of anomalous accessory renal vessels and testicular arteries arising from them before performing any transplantation surgeries, as kidney transplantation with multiple renal arteries has a chance of rejection, tubular necrosis and poor graft function. Anatomical knowledge of these vascular patterns and planning the appropriate surgical procedures to avoid any vascular complication can be executed with the help of multidetector computer tomography, angiography and arteriography prior to nephrectomy procedures.

Awareness of the above-mentioned variations of the renal arteries is necessary for adequate surgical management in the exploration and treatment of renal trauma, renal transplantation and urological operations

References

- Hollinshead WH (1971) *Anatomy for surgeons*, vol 2. Harper and Row, New York, pp 963–964
- Osan H et al (1995) High origin of gonadal arteries associated with other variations. *Ann Anat* 177:157–160
- Petru B et al (2007) The morphology and the surgical importance of the gonadal arteries originating from the renal artery. *Surg Radiol Anat* 29:367–371
- Paraskevas GK et al (2011) High origin of a testicular artery: a case report and review of the literature. *J Med Case Reports* 5:75
- Pai MM et al (2008) A cadaveric study of the testicular artery in the South Indian population. *Singapore Med J* 49(7):551–555
- Sylvia S et al (2009) Bilateral variant testicular arteries with double renal arteries. *Cases J* 2:114
- Ravery V, Cussenot O, Desgrandchamps F, Teillac P, Martin-Bouyer Y, Lassau JP (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(4):355–359
- Lippert H, Pabst R (1985) Arterial variations in man. *JF Bergmann*, Munchen, pp 28–29
- Asala S, Chaudhary SC, Masumbuko-Kahamba N, Bidmos M (2001) Anatomical variations in the human testicular blood vessels. *Ann Anat* 183:545–549
- Cicekcibasi AE, Salbacak A, Seker M, Ziyilan T, Buyukmumcu M, Uysal II (2002) The origin of gonadal arteries in human fetuses: anatomical variations. *Ann Anat* 184(3):275–279
- Shoja MM, Tubbs RS, Shakeri AB, Oakes WJ (2006) Origin of the gonadal artery: embryologic implication. *Clin Anat* 56:229–236
- Bergman RA, Afifi AK, Miyauchi R (1988) *Compendium of human anatomical variations*. Urban and Schwarzenberg: Baltimore
- Williams NS, Bulstrode CJK, O'Connell PR (2008) *Bailey and love's short practice of surgery*, 26th edition. London: ELBS, pp 1325–1331
- Breda A, Veale J et al (2007) Complications of laparoscopic living donor nephrectomy and their management: the UCLA experience. *Urology* 69(1)
- Akbar SA, Jafri SZ, Amenola MA, Madrazo BL, Salem R, Bis KG (2005) Complications of renal transplantation. *Radiographics* 25(5):1335–1356
- Sanson JR, Hall JR, Barnes AD, Robinson BH, Blainey JD (1978) The significance of vascular anomalies in human renal transplantation. *Proc Eur Dial Transplant Assoc* 15:345–351