

A cadaveric study of the testicular artery in the South Indian population

Pai M M, Vadgaonkar R, Rai R, Nayak S R, Jiji P J, Ranade A, Prabhu L V, Madhyastha S

ABSTRACT

Introduction: The male gonadal arteries, namely the testicular arteries, may vary at their origin and arise from the renal artery, suprarenal artery or lumbar artery. They may also be doubled, tripled or even quadrupled and may arise as a common trunk. With the advent of new intra-abdominal operative and laparoscopic techniques, the anatomy of the gonadal vessels has assumed much more importance. Therefore, a study was designed to assess the percentage of normal and aberrant origin and course of the testicular artery in the Indian population.

Methods: The posterior abdominal walls of 34 male cadavers (68 sides) were dissected and studied for the variations in the origin and course of the testicular arteries.

Results: In 85.3 percent of the cases, the male gonadal artery was normal in origin, number and course. However, in the remaining 14.7 percent, various anomalies in the testicular artery were noted.

Conclusion: The variations in the testicular arteries are attributed to their embryological origin. A deep knowledge of these variations and their relations to the adjacent structures is very important in avoiding the complications in operative surgery.

Keywords: anatomical variants, gonadal artery, inferior polar artery, suprarenal artery, testicular artery

Singapore Med J 2008;49(7):551-555

INTRODUCTION

Testicular arterial anatomy has been well studied because of its importance in testicular physiology, as well as testicular and renal surgery.⁽¹⁾ The gonadal arteries most commonly arise from the front of the abdominal aorta at the second lumbar vertebral level. Each testicular artery passes obliquely downwards and posterior to the peritoneum on the psoas major muscle, and enters the

inguinal canal through the deep inguinal ring. Along their course, the testicular arteries are accompanied by the testicular veins. Though the anatomical features of the testicular vessels are relatively constant,^(2,3) occasional developmental and anatomical variations have been reported.^(4,5) In 5%–20% of cases, the testicular artery has a more superior origin, and in 5%–6% of cases, it originates from the main or accessory renal artery.⁽³⁻⁸⁾

According to Notkovich in 1956, the gonadal arteries have been classified into three types based on their anatomical relationship to the renal vein: Type I – the gonadal arteries arise from the aorta behind or below the renal vein and pass downwards and laterally into the inguinal canal. Type II – the artery arises from the aorta above the level of renal vein and crosses in front of it. Type III – the gonadal arteries arise from the aorta behind or below the renal vein and course upwards to arch over the renal vein.⁽⁹⁾

The gonadal artery variations were more commonly found in male than female foetuses, and more on the right side rather than the left.⁽¹⁾ In the present study, we investigated the origin and course of the testicular arteries and discuss their clinical significance and embryonic development. As the number of abdominal surgical interventions and radiological investigations increase, a better understanding of the anatomy of testicular arteries gains importance.

METHODS

The posterior abdominal walls of 34 adult (40–60 years) male cadavers (68 sides) were dissected and studied for the variations in the origin and course of the testicular arteries. All subjects were Dravidians of south Indian origin. The abdominal cavity was opened by routine dissection procedure, and the retroperitoneal structures were exposed. The connective tissue surrounding the great vessels and their branches and tributaries were removed to provide a clear field of vision. The testicular arteries were observed, in particular for their origin and course. The data collected from there was noted and compared with statistics culled from other sources cited in literature.

RESULTS

We found that in 85.3% of the cases, the testicular

Department of Anatomy, Centre for Basic Sciences, Kasturba Medical College, Mangalore 575004, Karnataka, India

Pai MM, MBBS, MD
Assistant Professor

Vadgaonkar R,
MBBS, MD
Assistant Professor

Rai R, MSc
Lecturer

Nayak SR, MSc
Lecturer

Jiji PJ, MSc
Lecturer

Ranade A, MSc, PhD
Assistant Professor

Prabhu LV, MBBS,
MD
Professor

Madhyastha S, MSc,
PhD
Assistant Professor

Correspondence to:
Dr Mangala M Pai
Tel: (91) 824 2211 746
Fax: (91) 824 2428 183
Email: drmmpai@gmail.com

Table I. Variations in the origin of the testicular artery.

Origin of testicular artery	Right side	Left side
From the inferior polar artery	3	2
From the main renal artery	1	0
High origin from abdominal aorta	0	3
Double testicular artery	1	0

artery was normal in origin, number and course, as per the description that is usually referred to in standard anatomical textbooks. However, in the remaining 14.7%, various anomalies in the testicular artery were noted (Table I). The following variations were seen to be coexisting with multiple renal vessels, either artery or vein:

- Variation 1 – The testicular artery as a branch of the inferior polar artery. This anomalous pattern was seen in five sides (7.4%), three right and two left. All cases followed the normal course (Fig. 1), however, in one case, the testicular artery was very tortuous and was traversing behind the abdominal part of the ureter (Fig. 2).
- Variation 2 – The testicular artery as a branch of the main renal artery. On one right side, the testicular artery was a branch of the main renal artery originating as a common trunk along with the renal capsular artery and descended downwards crossing the right renal vein anteriorly (Fig. 3). In the same case, multiple suprarenal branches arising from the main renal trunk were also noted.
- Variation 3 – High origin of the testicular artery. Three left sides presented a more superior aortic origin of testicular artery as high as the renal artery origin (Figs. 4 & 5). In all these cases, the testicular artery arched over the ipsilateral renal vein. In one specimen, duplication of testicular vein was noted (Fig. 4).
- Variation 4 – Double testicular artery. On one right side, there were double testicular arteries—the lateral and the medial testicular arteries (LTA and MTA). LTA arose from the upper prehilum right renal artery (RRA) and coursed over the anterior surface of the right kidney, and the MTA emerged on the anterior surface of the abdominal aorta, 1.3 cm below the origin of the RRA, as a common trunk along with the inferior suprarenal and renal capsular arteries. The MTA then coursed below the inferior vena cava, to run parallel to the testicular vein (Fig. 6).

DISCUSSION

The anomalies of the testicular arteries include variations of their origin, course and number.^(4,9-11) They may be missing, or one or both arteries may arise from the renal artery, suprarenal artery, or lumbar artery. They may also arise from a common trunk or be doubled, tripled, or quadrupled.⁽¹²⁾ The anomalous origin of the testicular artery from the inferior polar artery of the kidney and its

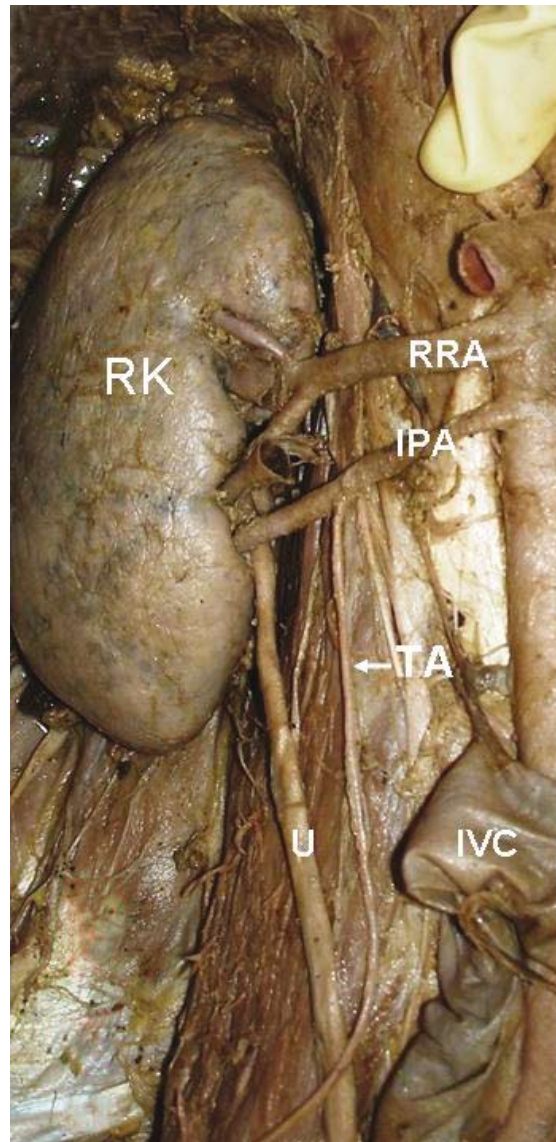


Fig. 1 Photograph, taken with the right retroperitoneal space exposed and inferior vena cava retracted, shows the origin of the right testicular artery from the inferior polar artery.

IVC: inferior vena cava; TA: testicular artery; IPA: inferior polar artery; RK: right kidney; RRA: right renal artery; U: ureter

surgical importance have been reported by Ravery et al, in which the authors stated that “this appears to be only the second description of this anomaly”.⁽⁷⁾ This is in contrast with the results of the present study wherein 8.8% of sides, the gonadal artery originated from the main or accessory renal artery. This agrees with the findings of Shoja et al, who reported that in 14% of sides, the gonadal artery originated from the main or accessory renal artery and an origin from the inferior polar artery (7%) was the most common finding.⁽¹³⁾ Otulakowski and Woźniak found an aberrant testicular artery that originated from the main renal artery and passed posterior to the inferior vena cava, similar to our variation, the only difference being that the origin of the aberrant artery was from the lower polar artery.⁽¹⁴⁾

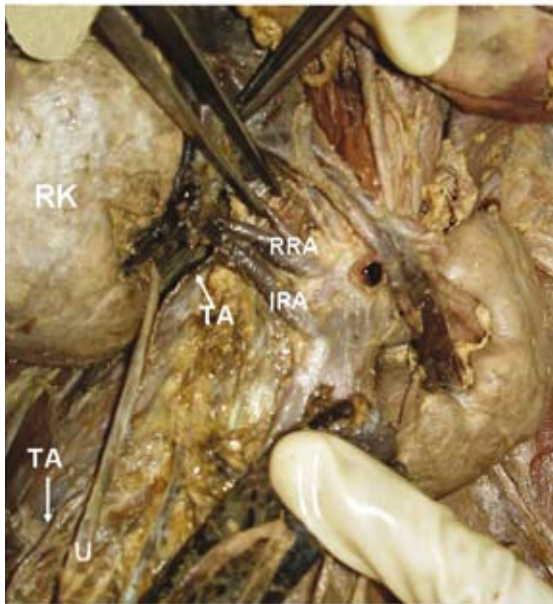


Fig. 2 Photograph, taken with the posterior abdominal wall structures exposed and inferior vena cava retracted, shows the origin of the right testicular artery from the inferior polar artery. Note the course of the GA behind the ureter.

TA: testicular artery; IPA: inferior polar artery; U: ureter; RK: right kidney, RRA: right renal artery.

Deepthinath et al reported a double left testicular artery, in which one originated from an accessory renal artery and the other from the main renal artery.⁽¹⁵⁾ An additional left testicular artery has been reported by Loukas and Stewart, where the accessory left testicular artery originated from the anterolateral wall of the descending aorta.⁽¹⁶⁾ Rusu described a case of bilateral doubled testicular arteries with a left testicular arterial arch around the left renal vein, very much similar to our variation.⁽¹⁷⁾ The origin of the inferior phrenic and suprarenal arteries from a high-origin testicular artery has also been described in the literature.^(10,18) In one case, we found that the gonadal and renal capsular artery arose from a common trunk on the right side. This agrees with the findings of Shoja et al.⁽¹³⁾ Ambos et al revealed that the gonadal artery may serve as a source of collateral blood supply to the kidney through the capsular arteries in such conditions as renal artery stenosis and renal tumours.⁽¹⁹⁾

Nathan et al described a case where both the right and left testicular arteries arched over the left renal vein.⁽²⁰⁾ Naito et al described two cases of the left testicular artery arching over the ipsilateral renal vein,⁽²¹⁾ similar to our finding. In addition, we observed an aberrant right testicular artery arching over the ipsilateral renal vein. Satheesha described a similar case of arching of the testicular artery, which was passing between the two divisions of the renal vein.⁽²²⁾ The testicular artery may get compressed between the renal veins, which may lead to degeneration of the testis.

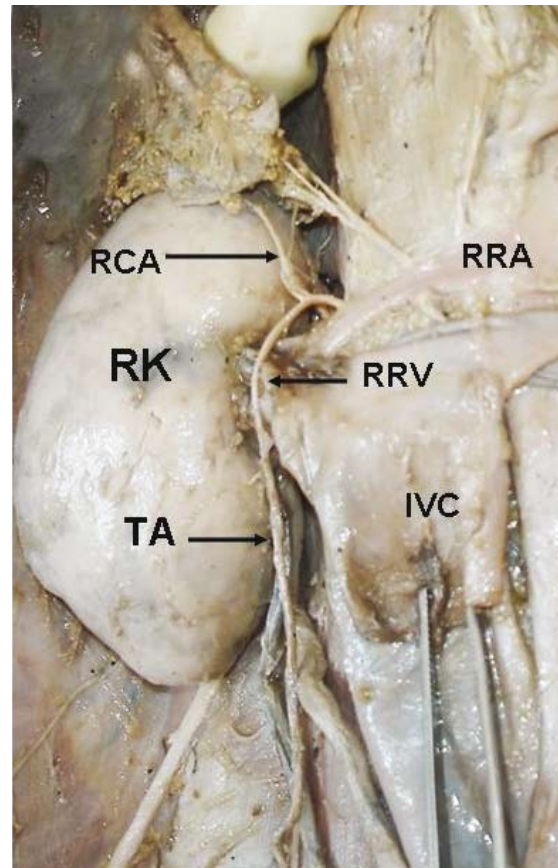


Fig. 3 Photograph, taken with the right retroperitoneal space exposed and inferior vena cava retracted downwards, shows the right renal artery and the anomalous origin of the right testicular artery.

IVC: inferior vena cava; TA: testicular artery; RRA: right renal artery; RK: right kidney, RRV: right renal vein, RCA: right capsular artery.

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 left renal vein (LRV) hypertension⁽²³⁾ resulting in varicocele, orthostatic proteinuria and haematuria.⁽²¹⁾ Compression of the 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 extrarenal collaterals and/or the development of gonadal vein reflux.⁽²³⁾

The developmental origins of the testicular blood vessels are very complex.⁽²⁴⁾ The first note on the embryological origin of the gonadal artery was made by Felix in 1912.⁽²⁵⁾ Nine lateral mesonephric arteries are divided into the cranial, middle and caudal group. One of the caudal arteries usually persists and differentiates into the definitive gonadal artery. The persistence of a cranial lateral mesonephric artery results in a high-origin of the gonadal artery,⁽²⁵⁾ probably from the suprarenal or from a more superior aortic level.⁽¹⁾ Persistence of more than one lateral mesonephric arteries results in doubled, tripled or quadrupled gonadal arteries. If the kidney

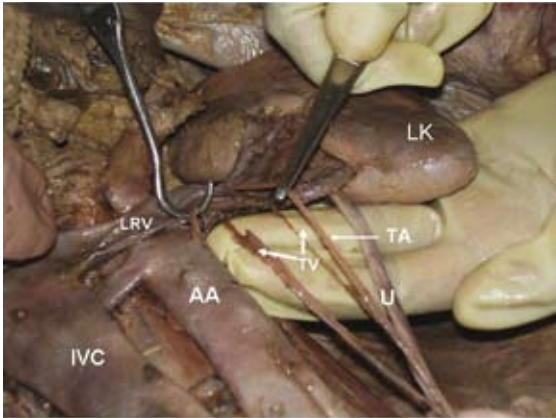


Fig. 4 Left retroperitoneal space dissected to expose the left kidney, inferior vena cava and abdominal aorta. The testicular artery arches over the left renal vein and the double testicular veins are visualised.

U: ureter; LK: left kidney; IVC: inferior vena cava; AA: abdominal aorta; TA: testicular artery; LRV: left renal vein; TV: double testicular veins

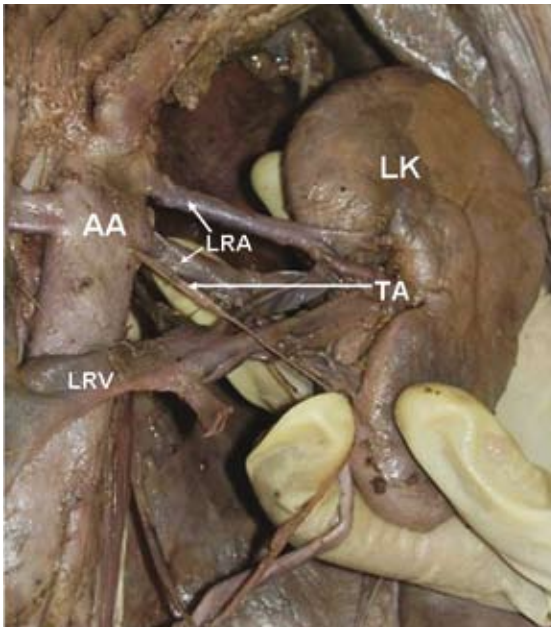


Fig. 5 Left retroperitoneal space dissected to expose the left kidney, abdominal aorta and left renal arteries. The testicular artery crossing the left renal vein is visualised.

LK: left kidney; AA: abdominal aorta; TA: testicular artery; LRA: left renal artery; LRV: left renal vein

ascends much higher, carrying its renal vein to a higher level than the origin of the gonadal artery, the latter will be forced to follow an arched course around the vein. The fact that on the left side, the kidney ascends generally higher than on the right, gives us a clear explanation of the higher frequency on the left side.⁽⁹⁾ 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.^(26,27)

It is known that genetics, various chemical agents,

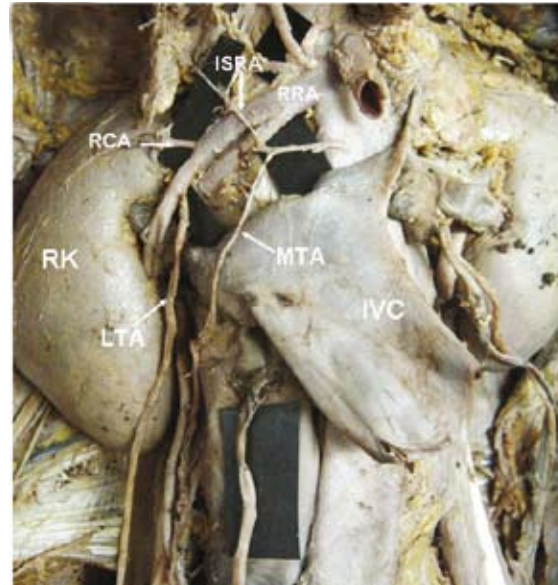


Fig. 6 Photograph, taken with the posterior abdominal wall structures exposed and inferior vena cava retracted downwards, shows the prehilum branch of the right renal artery giving rise to the lateral testicular artery. The trifurcation of the common trunk into the inferior suprarenal artery, renal capsular artery and medial testicular artery can be appreciated.

IVC: inferior vena cava; RRA: right renal artery; LTA: lateral testicular artery; ISRA: inferior suprarenal artery; RCA: renal capsular artery; MTA: medial testicular artery; RK: right kidney

growth/transcription factors and haemodynamic forces may all take part in the selection and persistence of a particular congenital vascular channel.^(28,29) However, the particular embryonic signals that result in the formation of an accessory renal artery or aberrant gonadal artery are yet unknown.⁽¹³⁾ 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. A deep knowledge of these variations and their relations to the adjacent structures is very important in avoiding the complications in operative surgery. With the advent of newer surgical and diagnostic techniques, understanding of atypical anatomical presentations gains more importance.

REFERENCES

1. Ciçekcibaşı AE, Salbacak A, Seker M, et al. The origin of gonadal arteries in human fetuses: anatomical variations. *Ann Anat* 2002; 184:275-9.
2. Ahlberg NE, Bartley O, Chidekel N. Right and left gonadal veins. An anatomical and statistical study. *Acta Radiol Diagn (Stockh)* 1966; 4:593-601.
3. Machnicki A, Grzybiak M. Variations in testicular arteries in fetuses and adults. *Folia Morphol (Warsz)* 1997; 56:277-85.
4. Mijac M, Goldner B, Joksimović B, Lolić-Draganović V. [Variations in the origin of ovarian and testicular arteries]. *Srp Arh Celok Lek* 1983; 111:609-15. Serbian.
5. Asala S, Chaudhary SC, Masumbuko-Kahamba N, Bidmos M. Anatomical variations in the human testicular blood vessels. *Ann Anat* 2001; 183:545-9.
6. Merklin RJ, Michels NA. The variant renal and suprarenal blood supply with data on the inferior phrenic, ureteral and gonadal arteries. *J Int Coll Surg* 1958; 29(1 pt 1):41-76.

7. Ravery V, Cussenot O, Desgrandchamps F, et al. 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* 1993; 15:355-9.
8. Bergman RA, Afifi AK, Miyauchi R. Gonadal. (Ovarian and Spermatic or Testicular) Arteries. In: *Anatomy Atlases* [online]. Available at: www.anatomyatlases.org/AnatomicVariants/Cardiovascular/Text/Arteries/Gonadal.shtml. Accessed May 1, 2006.
9. Notkovich H. Variation of the testicular and ovarian arteries in relation to the renal pedicle. *Surg Gynecol Obstet* 1956; 103:487-95.
10. Shinohara H, Nakatani T, Fukuo Y, Morisawa S, Matsuda T. Case with a high-positioned origin of the testicular artery. *Anat Rec* 1990; 226:264-6.
11. Ozan H, Gümüştalan Y, Onderoğlu S, Simşek C. High origin of gonadal arteries associated with other variations. *Ann Anat* 1995; 177:156-60.
12. Bergman R.A, Cassell M.D, Sahinoglu K, Heidger PM Jr. Human doubled renal and testicular arteries. *Ann Anat* 1992; 174:313-5.
13. Shoja MM, Tubbs RS, Shakeri AB, Oakes WJ. Origins of the gonadal artery: embryologic implications. *Clin Anat* 2007; 20:428-32.
14. Otulakowski B, Woźniak W. A case of origin of the testicular artery from the renal artery and course of the testicular artery behind the inferior vena cava. *Folia Morphol (Warsz)* 1975; 34:349-51.
15. Deepthinath R, Satheesha Nayak B, Mehta RB, et al. Multiple variations in the paired arteries of the abdominal aorta. *Clin Anat* 2006; 19:566-8.
16. Loukas M, Stewart D. A case of an accessory testicular artery. *Folia Morphol (Warsz)* 2004; 63:355-7.
17. Rusu MC. Human bilateral doubled renal and testicular arteries with a left testicular arterial arch around the left renal vein. *Rom J Morphol Embryol* 2006; 47:197-200.
18. Brohi RA, Sargon MF, Yener N. High origin and unusual suprarenal branch of a testicular artery. *Surg Radiol Anat* 2001; 23:207-8.
19. Ambos MA, Bosniak MA, Lefleur RS. Blood flow to the kidney via the gonadal-renal capsular artery. *Urol Radiol* 1979; 1:11-6.
20. Nathan H, Tobias PV, Wellsted MD. An unusual case of right and left testicular arteries arching over the left renal vein. *Br J Urol* 1976; 48:135-8.
21. Naito M, Terayama H, Nakamura Y, et al. Left testicular artery arching over the ipsilateral renal vein. *Asian J Androl* 2006; 8:107-10.
22. Satheesha NB. Abnormal course of left testicular artery in relation to an abnormal left renal vein: a case report. *Kathmandu Univ Med J* 2007; 5:108-9.
23. Rudloff U, Holmes RJ, Prem JT, et al. Meso-aortic compression of the left renal vein (nutcracker syndrome): case reports and review of the literature. *Ann Vasc Surg* 2006; 20:120-9.
24. Xue HG, Yang CY, Ishida S, et al. Duplicate testicular veins accompanied by anomalies of testicular arteries. *Ann Anat* 2005; 187:393-8.
25. Felix W. Mesonephric arteries (aa. Mesonephricae). In: Keibel F, Mall FP, eds. *Manual of Human Embryology*. Vol 2. Philadelphia: Lippincott, 1912: 820-5.
26. Bannister LH, Berry MM, Collins P, et al, eds. *Gray's Anatomy*. 38th ed. Edinburgh: Churchill Livingstone, 1995:1557-8, 318.
27. Moore KL, Persaud TVN. *The Developing Human*. 5th ed. Philadelphia: WB Saunders, 1993: 304-50.
28. Arey LB. *Developmental Anatomy*. Philadelphia: Saunders, 1965: 365-8.
29. Woolf AS, Yuan HT. Development of kidney blood vessels. In: Vize PD, Woolf AS, Bard JBL, eds. *The Kidney: From Normal Development to Congenital Disease*. Amsterdam: Academic Press, 2003: 251-66.