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Original Research Article

Morphological Study of Renal Arteries in South Indian Population

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Abstract: This study is aimed to determine the variations in perihilar branching pattern and extra renal arteries in 25 cadavers at SRM medical college hospital and research center, Chennai, India. Among the 50 kidneys studied, perihilar branching pattern (32%), accessory renal artery (26%), polar renal artery (16%), accessory renal artery & perihilar branching pattern (12%), accessory renal artery & polar artery (10%) and polar renal artery & perihilar branching pattern (4%) were observed in 16, 13, 8, 6, 5 and 2 cases, respectively. The knowledge of these probable variations of renal arteries will be useful for surgical management during renal transplantation, angiographic interventions, urological procedures and repair of abdominal aorta aneurysm**.**

Keywords: Kidney, renal arteries, variations, branching pattern.

INTRODUCTION

The bean-shaped kidneys are retroperitoneal in the posterior abdominal region [1]. Kidneys maintain the homeostasis of various substances, electrolyte and water in the body by excretion of metabolic end products and excess water [2-4]. Kidneys exhibits endocrine functions, producing and releasing erythropoietin (involved in red blood cell formation), renin (influences blood pressure) and 1,25dihydroxycholecalciferol (the metabolically active form of vitamin D) [5].

Kidneys are supplied by renal arteries [6]. Renal artery variations are more common. Variations regarding their origin and number have been reported by many researchers [7-9]. Renal artery variations are divided into two groups, early division and extra renal arteries. Branching of the main renal arteries into segmental branches more proximally than the renal hilus level is called early division. Extra renal arteries are of two groups: hilar (accessory) arteries and polar (aberrant) arteries. Hilar arteries and polar arteries enter kidneys from the hilum with the main renal artery and from the capsule outside the hilus, respectively. An accessory renal artery arising from the aorta supplies upper and lower pole of the kidney without passing through the hilum. An accessory artery is the precocious origin of a segmental artery.

As the invasive interventions such as renal transplantation, interventional radiological procedure and urologic operations increases, awareness of the possible variations of the renal arteries is necessary for the adequate surgical management in the abovementioned specialties. The present study is aimed to analyse the variations in perihilar branching pattern and extra renal arteriesin 25 cadavers of both sexes.

MATERIALS AND METHODS

In the present study, the following tools: Scalpel, toothed forceps, blunt forceps, scissors, retractor, hook, pointed forceps and blunt needle were used for the dissection of the cadavers.

The present study was under taken in the department of anatomy, SRM medical college hospital and research center, Kattankulathur, Chennai, Tamilnadu, India. The study was conducted in 25 cadavers of both sexes. About 50 kidneys were studied after various organs including stomach, liver, spleen, duodenum with pancreas were removed and preserved as specimens for teaching purposes. Ureters were also reflected along with the urinary bladder for proper visualization of branching pattern of renal arteries and extra renal arteries.

RESULTS

The percentages of variation in renal arteries and number of cases are summarized in Table 1.

Table-1: Percentage of variation of renal arteries

Variation in renal arteries	No. of cases	Percentage (%)
Perihilar branching pattern (PBP)		
Fork pattern	2	4
Doublet	4	8
Triplet	3	6
Ladder	7	14
Accessory renal artery		
Double renal artery (DRA)	10	20
Triple renal artery (TRA)	3	6
Polar renal artery		
Superior polar artery (SPA)	6	12
Inferior polar artery (IPA)	2	4
Accessory renal artery& perihilar branching pattern		
Double renal artery &Perihilar branching pattern (DRA & PBP)	6	12
Accessory renal artery & polar artery		
Double renal artery & Superior polar artery (DRA &SPA)	3	6
Double renal artery & Inferior polar artery (DRA& IPA)	2	4
Polar renal artery& perihilar branching pattern		
Superior polar artery &Perihilar branching pattern (SPA & PBP)	2	4

DISCUSSION

Soni and Wadhwa [10] reported the presence of double renal arteries on the left side and triple renal arteries on the right side. They reported incidence of triple renal arteries to be 1-2%.In the present study, double renal arteries were seen on both sides with same frequency. In 2 cases triple renal arteries on the right side and 1 case on left side were observed. Incidence of triple renal arteries is about 6% (Figures 1,2,5,7 and 9).

Shoja *et al*. [11] studied the perihilar branching pattern of renal artery. They observed fork pattern in 92.6% kidneys, duplicate in 80.2%, triplicate in 12.4% and ladder pattern in 7.4% kidneys.In the present study, perihilar multiple branching of renal arteries in 16 (32%) cases, fork pattern in 2%, duplicate in 4%, triplicate in 3%and ladder pattern in 7%. (Figures 1, 3 and 5).

Saldarriaga *et al*. [12] reported ninety seven (24.9%) out of 390 kidneys having additional arteries; 87 (22.3%) had one additional artery and 10 (2.6%) had two additional arteries. The frequency of one additional artery was 43.5% on right side and 56.3% on left side. There was discrepancy regarding the side and additional arteries were presented. In this study, out of 50 kidneys 13 (26%) had additional arteries, 10 (20%) had one additional arteries and 3 (6%) had two additional arteries. The frequency of additional artery was equal on both sides and of higher frequency on the right side (Figures 1,2,5,7 and 9).

Rusu *et al*. [13] reported bilateral double renal arteries on the right side as superior hilar and inferior hilar renal arteries and on the left side as superior hilar and inferior polar renal arteries.In the present study, presence of bilateral double renal arteries were seen on the right side as superior hilar and inferior hilar arteries and on the left side as superior polar and inferior hilar arteries (Figure 9 and 10).

Bordei *et al*. [14] studied renal vascularization and reported 54 cases of double renal arteries supplying one kidney and originating from aorta. Of the 54 cases, six cases were bilateral. In about 28 cases, supplementary renal artery entered the kidney through the hilum, in 16 cases it was inferior polar, in five cases it was superior polar artery. As per the observation in this study, about 10 cases of double renal arteries and 3 cases of triple renal arteries supplying one kidney and originating from abdominal aorta was observed. Of the 10 cases, 3 cases are bilateral. In 6 cases, supplementary renal artery entered the kidney through the hilum, in 2 cases it was superior polar artery and in 2 cases it was inferior polar artery (Figures 1, 2, 5, 7 and 9).

Incidence of multiple arteries has been reported to be 20.2% and 19% on right and left sides, respectively by Janschek *et al*. [15]. In the present study 64% of multiple renal arteries have been observed (Figure on 1, 2, 7 and 9).

Bayramoglu *et al*. [16] reported a variant which consisted of bilateral additional renal arteries originating from the abdominal aorta and an additional

right renal vein accompanying the additional right renal artery. These anomalies were associated with unrotated kidneys with extra renal calyces and pelvis. In the present study, 2 cases of bilateral triple renal arteries originating from the abdominal aorta and additional renal veins accompanying the triple renal arteries on both sides (Figure 8).

Bulic *et al*. [17] reported that the right kidney received two renal arteries from the aorta which were similar in diameter, both entering through the hilum. The left kidney had three arteries originating from the aorta, one at its usual hilar position and two entering the renal cortex at its upper and lower poles. The upper pole of the left kidney also gave rise to an additional tributary of the renal vein. It is important to be aware that accessory renal arteries are terminal arteries; therefore, if an accessory artery is damaged, the part of the kidney which is supplied by it is likely to become ischaemic. In the present study, the right kidney received two renal arteries from the abdominal aorta which is of same diameter. Both of them entered through the hilum. The left kidney had triple renal arteries. Of this two renal arteries entered the renal cortex at the hilum and the third renal artery entered through the inferior pole of the kidney (Figure 7 and 9).

Beyer and Daily [18] have reported a case of two renal arteries on the right side and one supplying the upper pole (superior polar) being more vertical in trajectory than the usual main renal artery (as reported in the present study on left side), causing upper pole infarction. In the present study, 3 cases of two renal arteries supplying superior pole of the kidneys. The polar arteries supplying superior pole had the usual renal artery branching pattern (Figure no 1, 2, 3, 4, 9 and 10).

Kadir [19] stated that the rate of early division in the general population is 15%, that aberrant renal arteries are observed twice as often as accessory renal arteries, the frequency rate of extra renal arteries is the same on the right and left sides, and that in 12% of the general population extra renal arteries are bilateral. In the current study, 26% of aberrant renal arteries were observed, the frequency rate of extra renal arteries is more in right side and 20% of extra renal arteries is bilateral (Figures 1,2,3,5,6 and 9).

Loukas *et al*. [20] have reported the presence of 3 renal arteries on the right side and 2 on the left. On the right side, one accessory renal artery originated as a common trunk with the inferior mesenteric artery. Whereas, on left side testicular artery branched from the left renal artery. In the present study, two renal arteries on the right side and one on the left side. On the right side, the testicular artery branched from the lower renal artery. On the left side, one accessory renal artery originated from the lateral aspect of abdominal aorta at the level of origin of inferior mesentric artery (Figure 9).

Turgut *et al*. [21] have observed 2 polar arteries on the left kidney besides the normal renal artery. The upper polar artery arising just at the beginning of left renal artery and the lower one arising directly from the lateral wall of abdominal aorta. In the present study one renal artery on the right side and three renal arteries on the left side. The superior polar artery arising just at the beginning of right renal artery. On the left side the above two renal arteries enters the hilum and third renal artery arising directly from the lateral wall of abdominal aorta supplying inferior pole of the left kidney (Figure 9 and 11).

Singh *et al*. [22] have reported the presence of bilateral accessory renal arteries which are giving origin to both the right and left gonadal arteries. In the present study, a case of bilateral accessory renal arteries, the gonadal artery was seen originated from the right renal artery (Figure 6).

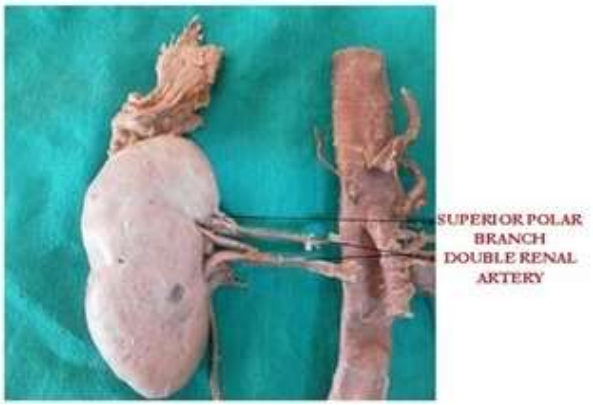

Fig-1: Double renal artery and perihilar branching pattern – ladder pattern

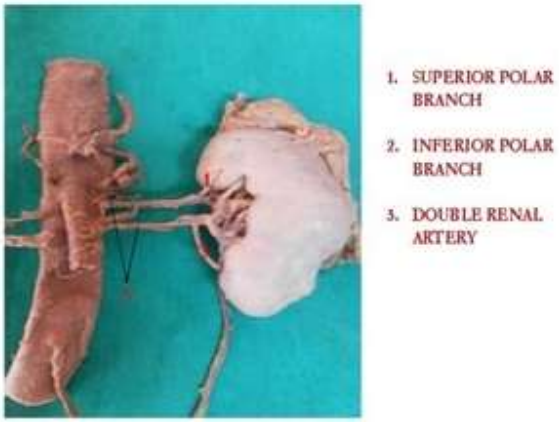

Fig-2: Double renal artery

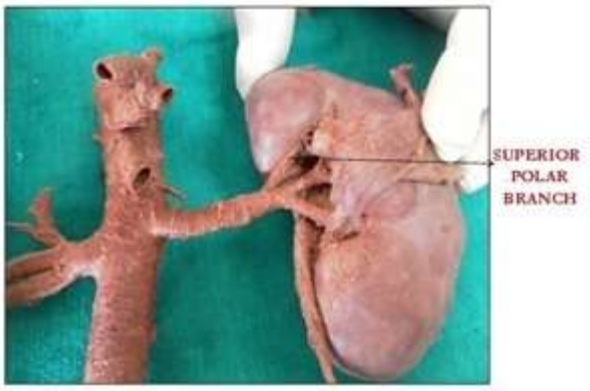

Fig-3: Perihilar branching pattern triplet

Fig-4: Perihilar branching pattern - net pattern

Fig-5: Perihilar branching pattern - fork pattern

Fig-6: Double renal artery and testicular artery

Fig-7: Triple renal artery

Fig-8: Triple renal artery with veins

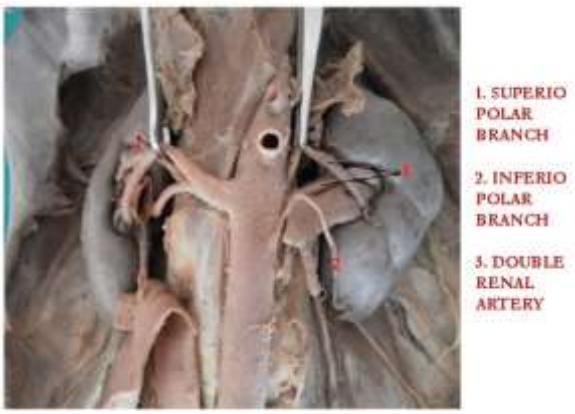

Fig-9: Double renal artery

Fig-10: Double renal artery

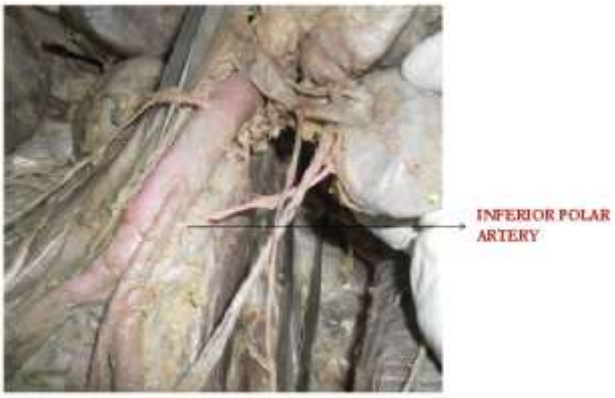

Fig-11: Inferior polar artery

CONCLUSION

In this study, variations in perihilar branching pattern and extra renal arteries were analysed. Variations in the origin and course of renal arterial blood supply occur frequently. Variations of renal artery are significant for urologist, renal transplantation, laparoscopic surgeons, radiologists and oncologist.

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CONFLICT OF INTERESTS

Authors declare no conflict of interest for this article.

REFERENCES

1. Standring, S. (2008). Gray's Anatomy. The Anatomical Basis of Clinical Practice. 40th Ed., Edinburg, Churchill & Livingstone, p1231-1233.
2. Yi-Fang, W., Jia-Jiun, Y., Yung-Che, T., Ruo-Dong, C., Pung-Pung, H. (2015). Molecular physiology of an extra-renal Cl- uptake mechanism for body fluid Cl- homeostasis. International Journal of Biological Sciences, 11(10), 1190-1203.
3. Blaine, J., Chonchol, M., Levi, M. (2015). Renal control of calcium, phosphate, and magnesium homeostasis. Clinical Journal of American Society of Nephrology, 10(7), 1257-1272.
4. Weiner, I.D., Mitch, W.E., Sands, J.M. (2015). Urea and ammonia metabolism and the control of renal nitrogen excretion. Clinical Journal of American Society of Nephrology, 10(8), 1444-1458.
5. Kurt, B., Kurtz, A. (2015). Plasticity of renal endocrine function. American Journal of Physiology, Regulatory, Integrative, Comparative Physiology, 308(6), R455-R466.
6. Khamanarong, K., Prachaney, P., Utraravichien, A., Tong-Un, T., Sripaoraya, K. (2004). Anatomy of renal arterial supply. Clinical Anatomy, 17(4), 334-336.
7. Kosuri, K.C. (2014). Unilateral multiple variations of renal, phrenic, suprarenal, inferior mesenteric and gonadal arteries. Journal of Natural Science, Biology and Medicine, 5(1), 173-175.
8. Kumaresan, M., Sankaran, P.K., Karthikeyan, G., Gunapriya, R., Shilpakala, L.B., Sudakshina, C., Priyadarshini, A., Zareena, B.M. (2016). Variations in branching pattern of renal artery in kidney donors using CT angiography. Journal of Clinical and Diagnostic Research, 10(3), AC01–AC03.
9. Carlos Fernando de, M.J., Severino, A.A.N., Arlindo Monteiro de, C.J., Rafael, B.R., Gustavo, R.P.N., Carollyne Dantas de, O. (2016). Multidetector computed tomography angiography of the renal arteries: normal anatomy and its variations. Radiologia Brasileira, 49(3), 190-195.
10. Soni, S., Wadhwa, A. (2010). Multiple variations in the paired arteries of abdominal aorta – clinical implications. Journal of Clinical and Diagnostic Research, 4, 2622-2625.
11. Shoja, M.M., Tubbs, R.S., Shakeri, A., Loukas, M., Ardalan, M.R., Khosroshahi, H.T., Oakes, W.J. (2008). Peri-hilar branching patterns and morphologies of the renal artery: a review and anatomical study. Surgical and Radiologic Anatomy, 30(5), 375-382.
12. Saldarriaga, B., Pérez, A.F., Ballesteros, L.E. (2008). A direct anatomical study of additional renal arteries in a Colombian mestizo population. Folia Morphol (Warsz), 67(2), 129–134.
13. Rusu, M.C. (2006). Human bilateral double renal and testicular arteries with a left testicular arch around the left renal vein. Romanian Journal of Morphology and Embryology, 47, 197-200.
14. Bordei, P., Sapte, E., Iliescu, D., Dina, C. (2007). The morphology and the surgical importance of the gonadal arteries originating from renal artery. Surgical and Radiologic Anatomy 29(5), 367-371.
15. Janschek, E.C., Rothe, A.U., Hölzenbein, T.J., Langer. F., Brugger, P.C., Pokorny, H., Domenig, C.M., Rasoulrockenschau, S., Mühlbacher, F. (2004). Anatomic basis of right renal vein extension for cadaveric kidney transplantation. Urology, 63(4), 660-664.

16. Bayaramoglu, A., Demiryurek, D., Erbil, K. (2003). Bilateral additional renal arteries and an additional right renal vein associated with unrotated kidneys. Saudi Medical Journal, 24, 535-537.
17. Bulic, K., Ivkic, G., Pavic, T. (1996). A case of duplicated right renal artery and triplicated left renal artery. Annals of Anatomy, 178, 281-283.
18. Beyer, R.W., Daily, P.O. (2004). Renal artery dissection associated with GZ acceleration. Aviation, Space, and Environmental Medicine, 75(3), 284-287.
19. Kadir, S. (1991). Kidneys. In: kadir s et al. Atlas of normal and variant angiographic anatomy. Philadelphia; W.B. Saunders Company, p 387-429.
20. Loukas, M., Aparicio, S., Beck, A., Calderan., Kennedy, M. (20050. Rare case of right accessory renal artery originating as a common trunk with the inferior mesenteric artery; a case report. Clinical Anatomy, 18, 530-535.
21. Turgut, H.B., Perker, T., Anil, A., Karakose, M. (2001). Ureter duplication and polar renal arteries in the same case. Kaibogaku Zasshi, 76(3), 293-296.
22. Singh, G., Ng, Y.K., Bay, B.H. (1998). Bilateral accessory renal arteries associated with some anomalies of the ovarian arteries: a case study. Clinical Anatomy, 11, 417–420.