

**Study of the segmental arteries of kidney with its clinical significance****Anand A Jamkar\****Associate Professor, Department of Anatomy, Shri Bhausaheb Hire Government Medical College, Dhule, Maharashtra, India***Received: 09-05-2021 / Revised: 03-06-2021 / Accepted: 11-06-2021****Abstract**

More conservative methods in renal surgery are coming up nowadays. It has necessitated an accurate knowledge of renal vasculature. This knowledge is important for treatment of trauma of kidney, renal transplantation and embolization of renal artery. The recent literature reports great variations in renal blood supply. With an accurate knowledge of the anatomical variations, many operative and post operative complications can be avoided. Hence, it becomes necessary for the clinicians to be aware about the variations in the vasculature of kidney. The 'end artery' nature of the segmental arteries necessitates its precise anastomosis during surgery. Therefore, we aimed the study to detect the existence and incidence of the variations of the segmental arteries. This study was conducted on 530 pairs of kidneys of known sex. The specimens obtained were dissected meticulously. The branches of renal arteries were observed. **Results:** The renal artery was dividing into anterior segmental branches and posterior segmental branches. 72.83% of specimens had four anterior branches, and 63.76% showed single posterior branch. Variations in number of anterior branches and posterior branches were seen in 27.17% and 36.24% of cases respectively. The variations were commoner on right side and in males.

**Keywords :** Renal artery, renal artery branches

This is an Open Access article that uses a fund-ing model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

**Introduction**

Kidney is an important organ in the body. This paired organ receives nearly 20 to 25% of the cardiac output. Normally each kidney has one renal artery. Adjacent to hilum, it usually divides into two branches, viz. anterior and posterior. These branches divide further and form segmental branches which supply the renal vascular segments[1]. Collateral circulation does not exist between the renal segments; therefore, the segmental artery is 'end artery'. So, if a surgeon ligated it, he can have an almost bloodless field during operation. Among the renal morphological variations, the vascular pattern variant is most common. They are due to diversity in renal vein as well as renal artery. The variations in number of branches of renal artery result in variable segmental arteries. A more precise knowledge of vasculature becomes necessary for conservative methods in renal surgery. As the segmental artery is an end artery; therefore, if it is damaged, that renal segment is likely to become ischemic. Due to that chance of parenchymal loss increases, which may result in postoperative hypertension. Due to variations in segmental arteries, control of intra-operative bleeding is an important challenge during renal surgery. The uncontrolled hemorrhage may compel nephrectomy.

Now a days interventional radiological procedures and renal transplants are also increasing, and hence renal artery variations are becoming more important.

**Materials and Methods**

Total 530 pairs of formalin fixed specimens of kidneys obtained from known gender, constituted the material for the study. It comprised of 310 male and 220 female pairs. They were obtained from department of Anatomy. The renal arteries and their branches coursing to anterior and posterior aspects were meticulously dissected. The instruments used were- scissors, scalpel (blade no. 23), and forceps (both plane and tooth). Renal arteries and their branches were colored after applying gelatin suspension.

**Observations**

The renal artery branched into two divisions, anterior and posterior. These divisions further branched to form segmental arteries. It was found that segmental branches going to anterior aspect were two to six in numbers. The sex wise incidence on right and left side is shown in Table 1 and 2.

**Table 1: Incidence of Anterior branches on in Male**

No. of Branches	Right		Left	
	No. of cases	Percentage	No. of cases	Percentage
1	00	00	00	00
2	05	1.61	11	3.54
3	39	12.58	39	12.58
4	216	69.67	225	72.58
5	45	14.51	35	11.29
6	05	1.61	00	00

\*Correspondence

**Dr. Anand A Jamkar**

Associate Professor, Department of Anatomy, Shri Bhausaheb Hire Government Medical College, Dhule, Maharashtra, India

E-mail: [anand\\_jamkar71@yahoo.co.in](mailto:anand_jamkar71@yahoo.co.in)

**Table 2: Incidence of Anterior branches on in Female**

No. of Branches	Right		Left	
	No. of cases	Percentage	No. of cases	Percentage
1	00	00	00	00
2	11	5.00	11	5.00
3	20	9.09	15	6.81
4	159	72.27	169	76.81
5	25	11.36	15	6.81
6	05	2.27	10	4.54

Commonly kidneys showed four anterior branches. The incidence was highest in females on left side (76.81%). The minimum incidence was observed in males and on the right side (69.67%).

The branches coursing posterior were one to three in numbers. Their sex wise and side wise incidence is shown in Tables 3 and 4.

**Table 3: Incidence of Posterior branches on in Male**

No. of Branches	Right		Left	
	No. of cases	Percentage	No. of cases	Percentage
1	179	57.74	196	63.22
2	75	24.19	69	22.25
3	56	18.06	45	14.51

**Table 4: Incidence of Posterior branches on in Female**

No. of Branches	Right		Left	
	No. of cases	Percentage	No. of cases	Percentage
1	145	65.90	150	68.18
2	44	20.00	39	17.72
3	31	14.09	31	14.09

It can be concluded that single posterior artery was commonly observed. The maximum incidence was in females on left side, i.e., 68.18%. While minimum figure was observed in males on right side, i.e., 57.74% (Images 1 to 4)

#### Discussion

Graves FT[2] was the first to describe the segmental branches of renal artery. He has stated that, the kidney can be divided into five arterial segments (apical, upper, middle, lower and posterior) depending on the renal arterial distribution. Sykes[3] has described that, the renal artery divides into anterior and posterior branches in 83% of cases, which then gave rise to five segmental arteries. This pattern is commonly followed by most of the researchers.

In 1966, Fine[4] et al conceptualized a new pattern called primary and secondary branching. In this, the renal artery was divided into posterior, lower and upper primary branches. The intermediate and middle were the secondary branches and were sufficiently constant. This primary and secondary branching pattern was not considered for the present study.

Weld[5] et al in 2005 evaluated the segmental branches and their surgical access. According to them, the pre-segmental arteries were zero in 49.3%, one in 31.5%, and two in 19.2% of kidneys.

Prehilar multiple branching pattern was reported by Rao et al in 2006[6]. They have observed the segmental branches coursing to superior, middle, inferior and posterior vascular segments. Shoja MM[7] et al (2008) observed the renal artery for perihilar branching pattern. They observed fork pattern in 92.6%. The duplication was noted in 80.2% and triplication in 12.4% of kidneys.

Budhiraja[8] et al (2010) in their study quoted the incidence of prehilar multiple branches in 11.66% of cases. The branches were going towards five segments viz. apical, superior, middle, inferior and posterior. In 2010, Narendiran Krishnasamy[9] et al observed a right renal artery dividing into three branches, with an additional renal artery from aorta reaching lower part of hilum.

Teli CG[10] in 2012 reported a case of bilateral renal arterial variations. Right renal artery divided into two divisions - anterior and posterior. Anterior division then gave rise to five branches. This included one branch coursing to superior pole. Four branches were arising from posterior division. Similarly left renal artery also had two divisions. They were further giving rise to five branches from anterior division and four branches from posterior.

Gupta[11] et al in 2012 observed a case of variations in renal arteries on either side. The right sided kidney had three renal arteries, with upper one dividing into three branches. The left sided kidney had two renal arteries, with upper one dividing into five branches. Out of these five, three branches again bifurcated before entering the hilum. The lower renal artery of the left side branched into two divisions.

The renal artery branching was studied by Ecaterina Dăescu [12] et al in 2012. 70% of cases had two branches, 23.33% had three branches and 6.67% had four branches.

Nayak SB[13] et al in 2014 reported a case in which eight branches were arising from right renal artery. A single right renal artery was dividing into upper and lower divisions, which further divided into four and two branches respectively. These two branches from lower division bifurcated into two branches each.

In 2014, Goswami P[14] et al observed variations in renal vessels bilaterally. The left renal artery was quadruplicating before entering kidney. The right renal artery was dividing into two branches. The first branch was trifurcating before entering the hilum, while the second branch entered directly in the hilum.

In 2016 Kumaresan Munnusamy[15] et al observed that, in 13% of individuals there was an earlier division of renal artery. Anuj Ram Sharma[16] in 2018 have studied 80 kidneys and observed that in 6.5% of cases showed bilateral prehilar branching of renal arteries. All cases were having a separate segmental artery going to upper pole.

Mansur DI[17] in 2019 reported that, the hilar branching pattern was recorded in 38.83% kidneys and early branching pattern was recorded in 34.95% of kidneys.

The number of segmental arteries coursing anteriorly varied from two to six in the present study. They were four in number in majority of cases (72.83%). The segmental arteries going



Fig 1: Five anterior and Two posterior branches

to posterior aspect were one to three in numbers, with single being the commonest (63.76%). These segmental branches suggested their area of distribution and implied the vascular segments of the kidney.



Fig 2: Four anterior and One posterior branches



Fig 3: Four anterior and Three posterior branches



Fig 4: Five anterior and Three posterior branches

### Conclusion

For performing surgeries in the renal area, the knowledge of the renal vasculature is very significant. The technical feasibility of the surgery may be strongly influenced by the anomalies of segmental arteries. An importance of comprehensive knowledge of segmental arteries is much increased nowadays as it facilitates the clinical approaches during renal transplants. The information about variations in the segmental arteries has a large impact on outcome of nephron-preserving surgery. The segmental arterial information is helpful for performing endovascular, laparoscopic uro-radiological procedures as well as for the clinical management of renal vascular hypertension. This study is a small effort to detect the existence and incidence of the segmental arteries.

### References

1. Standring S. Kidney and Ureter. In Gray's Anatomy The Anatomical Basis of Clinical Practice, 40th ed. Edinburg: Churchill Livingstone Elsevier; 2008. p. 1231-3.
2. Graves FT. The anatomy of intrarenal arteries and its application to segmental resection of kidney. B.J.Surg 1954; 42: 132-9
3. Sykes D. The arterial supply of the human kidney with special reference to renal arteries. B.J.Surg 1963; 50:368-74
4. Fine H, Keen EH. The arteries of human kidney. J.Anat 1966; 100:113-37
5. Weld KJ, Bhayani SB, Belani J, Ames CD, Hruby G, Landman J. Extrarenal vascular anomaly of kidney: assessment of variations and their relevance to partial nephrectomy. Urology 2005; 66:985-9
6. Rao M, Bhat SM, Venkataramana V, Deepthinath R, Bolla SR. Bilateral prehilal multiple branching of renal arteries: a case report and literature review. Kathmandu Uni Med J 2006; 4:345-8
7. Shoja MM, Tubbs RS, Shakeri A, Loukas M, Ardalan MR, Khosroshahi HT, Oakas WJ. Peri-hilar branching patterns and

morphologies of the renal artery: a review and anatomical study. Surg. Radiol. Anat 2008; 30:375-82

8. Budhiraja V, Rastogi R, Asthana AK. Renal artery variations: embryological basis and surgical correlation. Rom. J. Morphol. Embryol 2010; 51:533-6.
9. Narendiran Krishnasamy, Mohardas Rao KG, Vincent Rodrigues. An unusual case of unilateral additional right renal artery and vein. International Journal of Anatomical variations 2010; 3: 9-11.
10. Teli CG, Usha Kothandraman. Complex and unusual variation of renal vessels – embryological basis and clinical significance. International Journal of Anatomical Variations 2012; 5:87-9.
11. Gupta V, Kotgirwar S, Singh V. Bilateral variations in renal vasculature. Int. J. Anat. Variations 2010; 3:53-5.
12. Ecaterina Dăescu, A Motoc, Aurora Alexa, Alexandra Enache. Morphological variability of the renal artery branching pattern: a brief review and an anatomical study Rom J Morphol Embryol 2012; 53:287-91.
13. Nayak SB, Shetty SD, Ravindra S, Sirasanagandla SR, Aithal AP, Patil J, et al. Eight prehilal branches of the right renal artery. Anat Cell Biol 2014; 47:214-6.
14. Goswami P, Yadav Y, Chakradhar V. Morphological study of renal vasculature in North India. European Journal of Academic Essays 2014; 1:76-9.
15. Kumaresan Munnusamy, Sankaran Ponnusamy Kasirajan, et al. Variations in Branching Pattern of Renal Artery in Kidney Donors Using CT Angiography. J Clin Diagn Res 2016; 10: ACO1-3.
16. Anuj Ram Sharma, Rakesh Kumar Agrawal, Hemant Saini, Seema Rani Khajuria, Anil Kumar Malik. Bilateral Prehilal branching of renal arteries. Int J. Anat Res 2018; 6:5511-4.
17. DI Mansur, S Karki, DK Mehta, A Shrestha, A Dhungana. A Study on Variations of Branching Pattern of Renal Artery with its Clinical Significance. Kathmandu Univ. Medical J 2019; 17:136-40

**Conflict of Interest: Nil Source of support: Nil**