

# Hilar renal arteries: A morphological study from central India with clinical correlation

Virendra Budhiraja<sup>1</sup>, Rakhi Rastogi<sup>1</sup>, Vishal Bankwar<sup>2</sup>, D.K. Sathpathi<sup>3</sup>

1- Department of Anatomy, L.N. Medical College, Bhopal (M.P), India

2- Department of Community Medicine, L.N. Medical College, Bhopal (M.P), India

3- Department of Forensic Medicine, L.N. Medical College, Bhopal (M.P), India

## SUMMARY

Prior knowledge of more than one hilar artery is important for surgeons who are performing renal transplant and other surgeries on kidney. The aim of this study is to observe such variations in cadavers from central India and to correlate it clinically. Eighty four formalin-fixed 84 cadavers (168 kidneys) constituted the material for study. Out of 84 cadavers 73 (146 kidneys) were male and 11 (22 kidneys) were female. During routine abdominal dissection conducted for medical undergraduates, kidneys along with their arteries were explored and the morphological variations of renal arteries were noted. We observed double hilar renal arteries in 21/146 (14.4 %) kidneys in male and 5/22 (22.7 %) kidneys in female. Three hilar renal arteries were observed in 3/146 (2.1%) kidneys in males and 1/22 (4.5%) kidney in females. We believe that awareness of the abovementioned variations of the renal arteries is necessary for adequate surgical management in exploration and treatment of renal trauma, renal transplantation and urological operations.

**Key words:** Kidney – Anatomical variations – Double renal arteries – Renal transplantation

## INTRODUCTION

Usually a single renal artery supplies each kidney. The renal artery arises from the abdominal aorta below, and runs lateral to the origin of the superior mesenteric artery, then it runs lateral to reach the hilum of the kidney, where it divides into anterior and posterior branches before entering the kidney (Healey, 2005). The most usual morphological variations encountered in the renal artery are its variable number and unusual branches originating from it (Dhar and Lal, 2005; Rusu, 2006; Shoja et al., 2008). Most of these variations remain undiscovered until they are noticed during any surgical procedure or found by a forensic pathologist during autopsy (Krishnasamy et al., 2010). Awareness of these possible variations of the renal arteries is necessary for surgical management during renal transplantation, repair of abdominal aorta aneurysm, urological procedures and angiographic interventions (Olsson and Wholey, 1964; Nathan and Glezer, 1984; Satyapal et al., 2001).

## MATERIAL AND METHODS

Eighty four formalin-fixed cadavers (168 kidneys) constituted the material for study. Out of 84 cadavers 73 (146 kidneys) were male and 11 (22 kidneys) were female. During routine abdominal dissection conducted for medical undergraduates at Department of Anatomy, kidneys along with their arteries were explored and the morphological variations of the renal arteries were noted. During the course of dissection various abdominal viscera were removed and preserved as specimen for teaching purposes.

## RESULTS

We observed double and triple hilar renal arteries. Double hilar renal arteries were unilateral (Fig. 1) or bilateral (Fig. 2) in male as well as in female cadavers, but the triple hilar renal arteries were unilateral (Fig. 3) in all the cases. Results are presented in Table 1 and Table 2.

Table 1. Percentage distribution of double and triple hilar arteries in relation to gender.

	N <sup>o</sup> . of kidneys	Double hilar arteries	Triple hilar arteries
Male	146	21/146 (14.4 %)	3/146 (2.1%)
Female	22	5/22 (22.7 %)	1/22 (4.5 %)
Total	168	26/168 (15.4%)	4/168 (2.4%)

Table 2. Number of unilateral and bilateral cases in relation to gender.

	Double hilar renal arteries	
	Unilateral cases	Bilateral cases
Male	9	6
Female	3	1

Out of 26 cases of double hilar artery in 24 cases the supernumerary renal hilar artery had its origin in the abdominal aorta, but in 2 cases it was originated from main renal artery (Fig. 1). We also observed constriction of 1 of the duplicated hilar renal artery (Fig. 2) in 3 cases indicating narrowing of lumen.

## DISCUSSION

Renal artery variations including their number, source, and course are very common, the most common being an additional or accessory artery arising above or below the

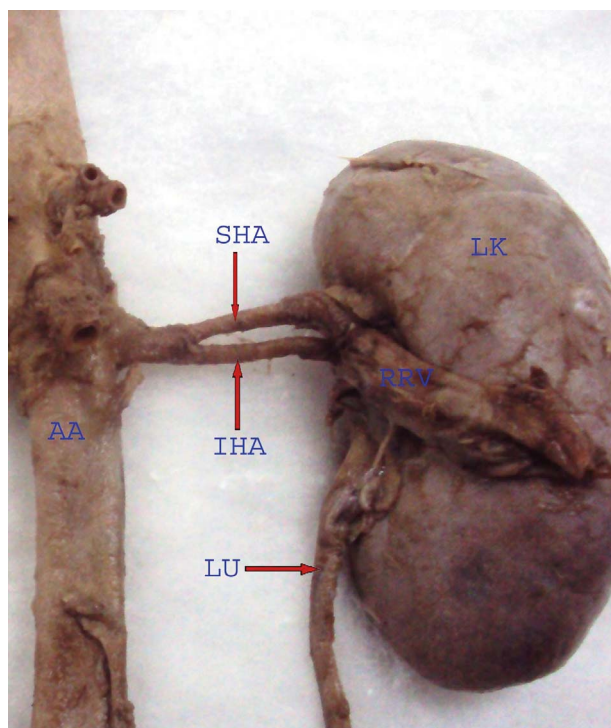


Fig. 1. Two unilateral hilar arteries. LK – Left kidney, AA – Abdominal aorta, RRV – Reflected renal vein, SHA – Superior hilar artery, IHA – Inferior hilar artery, LU – Left ureter.

usual renal artery (Bergman et al., 2011). Accessory renal arteries have been known since the early days of human autopsy. They have been reported to occur in 26% of individuals (Lippert and Pabst, 1985); in most cases they originate directly from the aorta (Gupta and Tello, 2004). The various types of accessory renal arteries, their positions, method of entry to the kidney, and their segmentation were studied extensively by several authors (Anson et al., 1936; Sykes, 1963; Cicekcibasi et al., 2005). When there are two or more renal vessels, the vessels do not anastomose within the substance of kidney, but each artery supplies a separate part of kidney; hence none of the multiple arteries can be regarded as accessory. Obstruction of any renal artery leads to cessation of function and death of the part of kidney supplied by it. The term accessory is therefore misleading, because they are not superfluous but essential tissue sustaining arteries without anastomosis between them, which correspond to the segmental branches of a single renal artery (Hollinshead, 1966; Sampaio and Passos, 1992; Madhyastha et al., 2001). We therefore used the term superior hilar, middle hilar and inferior hilar renal artery, depending upon its entrance into the kidney.

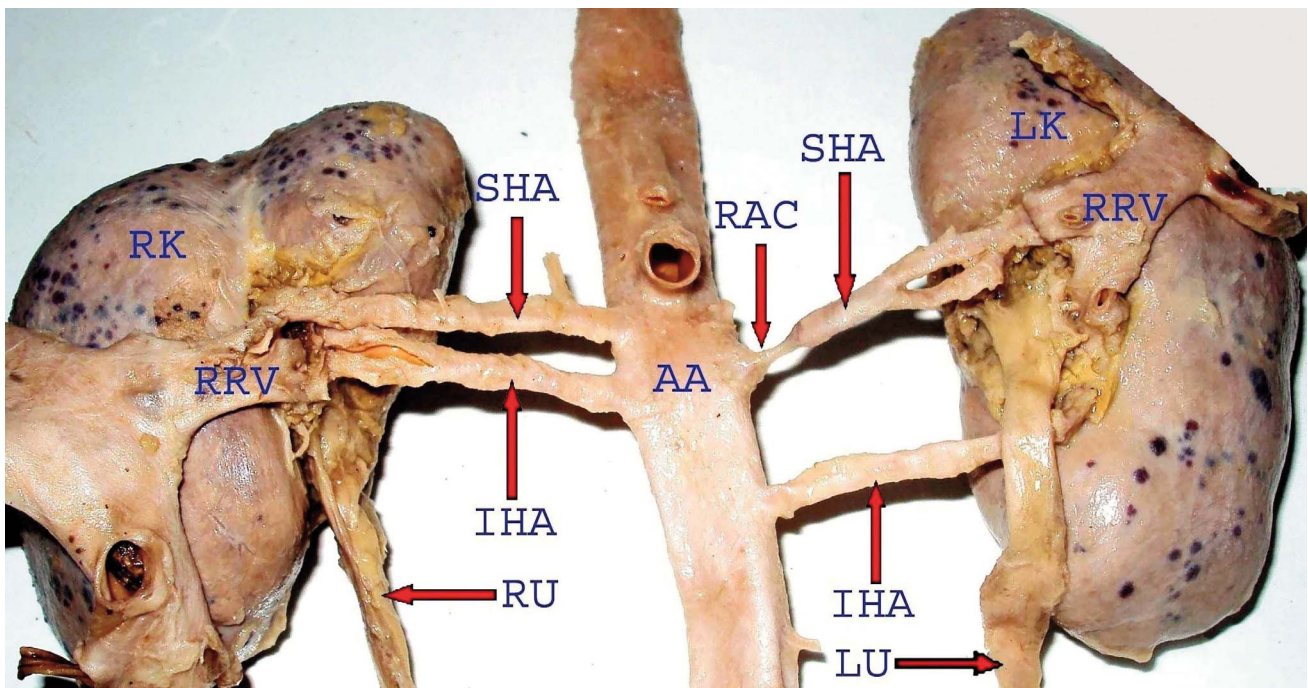


Fig. 2. Two bilateral hilar arteries. LK – Left kidney, SHA – Superior hilar artery, IHA – Inferior hilar artery, LU – Left ureter, RK – Right kidney, RU – Right ureter, RRV – Reflected renal vein, RAC – Renal artery constriction, AA – Abdominal aorta.

Merklin and Michels (1958) classified these supernumerary renal arteries depending upon origin as follows: supernumerary renal arteries originating from the aorta, supernumerary renal arteries originating from the main renal artery, and supernumerary renal arteries originating from other arterial sources. However, in their study none of the hilar supernumerary renal arteries took their origin from the renal artery. In the present study, the hilar supernumerary arteries originated from abdominal aorta in 24 cases, and from the main renal artery in 2 cases. We also compare the results of the present study with those from different population groups conducted in different years (Table 3), and found them closer to Colombian and Bosnian than to Caucasians and Thai populations.

Table 3. Comparison of findings in the present study with previous studies on different population groups.

Authors	Population group	Double hilar arteries
Sampaio and Passos (1992)	Caucasians (white)	7.9%
Khamanarong et al. (2004)	Thai	7.0%
Bordei et al. (2004)	Romanian	10.2%
Cicekeibasi et al. (2005)	Turkish	11.1%
Talovic et al. (2007)	Bosnian	17.9%
Saldarriaga et al. (2008)	Colombian	12.1%
Present study	Indian	15.4%

The embryologic explanation of these variations has been presented and discussed by Felix (1912). In an 18 mm fetus, the developing mesonephros, metanephros, suprarenal glands and gonads are supplied by nine pairs of lateral mesonephric arteries arising from the dorsal aorta. Felix divided these arteries into three groups as follows: the 1st and 2nd arteries as the cranial; the 3rd to 5th arteries as the middle, and the 6th to 9th arteries as the caudal group. The middle group gives rise to the renal arteries. Persistence of more than one artery of the middle group results as multiple renal arteries (Felix, 1912). Thus the 2 and 3 hilar renal arteries in our study are a result of persisting lateral mesonephric arteries from the middle group.

Glondy et al. (2000) observed more risk of hypertension in subjects with multiple renal arteries due to high plasma renin activity in these subjects. However, Gupta and Tello (2004) conducted a study on 185 hypertensive patients, and 45 patients (24%) showed accessory renal artery. Of these 45 patients, nine (20%) showed renal artery stenosis. In the present study we also observed constriction of one of the duplicated hilar renal artery in 3 cases indicating narrowing of lumen.

The anatomical knowledge of multiple arteries is essential before performing any transplantation surgeries where microvascular

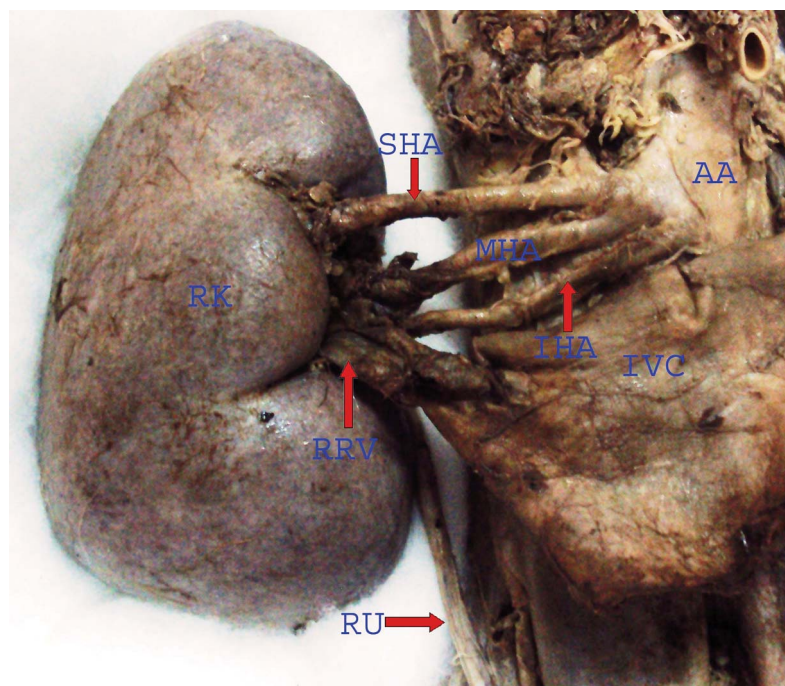


Fig. 3. Three hilar arteries. SHA – Superior hilar artery, MHA – Middle hilar artery, IHA – Inferior hilar artery, RK – Right kidney, RU – Right ureter, RRV – Reflected renal vein, AA – Abdominal aorta, IVC – Inferior vena cava.

techniques are employed to reconstruct the renal arteries (Brannen et al., 1982). One has to keep in mind that transplanting a kidney with accessory renal arteries has several theoretical disadvantages- acute tubular necrosis and rejection episodes, decreased graft function, prolonged hospitalization but due to 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 (Gupta et al., 2010; Kadotani et al., 2005). In order to know the vascular pattern and to plan appropriate surgical procedure multi detector computer tomography and arteriography should be performed prior to every nephrectomy (Kunwabara et al., 2006; Raman et al., 2007).

In conclusion, we believe that awareness of the abovementioned variations of the renal arteries is necessary for adequate surgical management in exploration and treatment of renal trauma, renal transplantation and urological operations.

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