Original article

Morphometric and quantitative analysis of the afferent renal artery variation

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Abstract

Introduction: The kidney is a retroperitoneal organ that weight from 125 to 170 g in the adult men and 115 to 155 g in adult women. Irrigation kidney is characterized by the presence of large anatomical variability that may be influenced by ethnic and to a lesser extent by gender. Among the variations, there may be the presence of an accessory renal artery that is projected into the upper or lower end of the kidney. This research aims to observe the incidence of anatomical variations of the afferent renal artery and quantify both right and left kidney weight. **Materials and Methods:** We analyzed kidney weights and accessory renal artery variations in 48 adult kidneys of both genders obtained from Institute of Anatomy of the University of Severino Sombra. Subsequently, we compared the mean weights of kidneys in order to ascertain whether there was significant discrepancy between the left and the right kidney. For this, we performed the Student t test considering a $P < 0.05$. **Results:** The mean weight of the right kidney was 140.4 ± 22.6 g and the left was 148.8 ± 20.5 g. In 40% of right kidneys was observed anatomic variation with the presence of accessory renal artery. To the left kidney was observed a variation of 35%. **Conclusion:** We found that the accessory renal artery, when present, was more closely related to the end of the kidney especially in the right kidney.

Keywords: kidney, variation, anatomy, morphometry, artery.

1 Introduction

The kidneys are retroperitoneal structures, located in the abdominal region beside the spine, between the last two thoracic vertebrae and the first three lumbar vertebrae, and its main task is to maintain the internal environment. These organs filter plasma, drawing an enormous volume of liquid and submitting this ultra-filtered to an additional process in which useful substances are reabsorbed, the waste substances are concentrated for disposal and its volume is adjusted to keep enough water in order to maintain the optimal plasma composition (MORAES and COLICIGNO, 2007).

The right kidney is slightly more caudal than the left one, probably due to its superior relationship with the liver. Its color is a dark brown and it has the form of a kidney bean, measuring about 12 cm high from 5 to 7.5 cm width and 2.5 cm thick. Its weight ranges from 125-170 grams in an adult male and 115 to 155 grams in an adult female (GARDNER, GRAY and O'RAHILLY, 1988; GRAY and GROSS, 1988; DIDIO, 1998; MOORE and DALLEY, 2007).

It should be emphasized that any distortion or imbalance in the functioning of the pre, intra and post-kidney structures, can trigger serious problems not only in the kidney, but also in the heart, as well as vascular, hemodynamic, and cerebral malfunctions which, if not diagnosed and treated in time, can become irreversible, reducing the quality of life whether these individuals present some neuropathology (MORAES and COLICIGNO, 2007).

The knowledge of variations in renal vascular anatomy is of great importance in the semiotic kidney operation and in other conditions, such as: treatment of renal injuries, renal transplantation, Renovascular hypertension, renal artery embolization, angioplasty or vascular reconstruction for congenital or acquired lesions, surgery for abdominal aortic aneurysm and both conservative or radical renal surgery, among others (SAMPAIO and ARAGÃO, 1990).

Recent advances and refinements in urology techniques and in the image diagnosis prompted the development of studies on kidney vascularization, being required anatomical knowledge to perform interventional maneuvers safely and effectively (FARINON, LAMPUGNANI, ZANNONI et al., 1984; SAMPAIO and PASSOS, 1992).

Current techniques of endourology have its procedures performed not only through the percutaneous renal excretory system or by ascending ducts from the urethra (CLAYMAN, SURYA, HUNTER et al., 1984; LANG, 1990) but also by laparoscopic nephrectomy to perform total or partial drainage of large cysts, pieloplastia, not mentioning renal drainage through puncture nephrostomy (FRANCISCO and SAMPAIO, 1992).

However, there was a further need to master the field of vascular anatomy, enabling the surgeon to lower complication rates, which may be a key factor in choosing the best surgical technique (KAYE and REINKE, 1984). One of the most serious complications of the percutaneous and the partial renal vascular surgeries is an injury at the moment of puncture or section of the renal parenchyma, which causes internal bleeding. The incidence of bleeding that requires blood transfusion may reach 12% (LEE, SMITH, CUBELLI et al., 1987). Another potential complication is the formation of arteriovenous fistula, described up to 3% of cases (WILSON and NOLAN, 1987).

How is it possible to increased incidence of unilateral renal hypertension and the presence of abnormalities in renal structures, anomalies should be rigorously studied (BUSATO JÚNIOR and RIBAS FILHO, 2003). Among these, the double renal artery should be considered for humans, especially when renal disorders are present or when abdominal surgical interventions are conducted near the kidneys in order to thereby avoid the errors committed by the lack of knowledge of important anatomical structures.

The presence of additional renal arteries corresponds to the most frequent change of this kind of vascularization, being important to renal surgery and radiological procedures (SAMPAIO and PASSOS, 1992).

Once the presence of various renal arteries has been associated with the increased rate of vascular complications, this research aims to observe the incidence of anatomical variations of the afferent renal artery and quantify both right and left kidney weight.

2 Materials and Methods

Weights and variations of accessory renal artery were analyzed in 48 adult kidneys of both sexes, obtained from the Institute of Anatomy of the University Severino Sombra. Subsequently, the average weights of the kidneys were compared in order to ascertain whether there was significant discrepancy between the left and the right kidney. For this, a T-Student test was carried out for both homogeneous samples, considering $P < 0,05$. Details of the study were submitted to and approved by the Ethics Committee of the University Severino Sombra.

3 Results

The average weight of the right kidney was 140.4 ± 22.6 g, and the left one was 148.8 ± 20.5 g (Table 1 and Figure 1). In 40% of the right kidneys with anatomic variation there was the presence of the accessory renal artery, ten for the upper pole and one for lower pole. To the left kidney, there was a variation of 35%, being six to the upper pole and one to the lower pole (Table 1).

In kidneys with more than one renal artery it has been frequent the designation of the afferent artery as aberrant, supernumerary, multiple, additional or incidental (Figures 2 and 3). As the term supernumerary indicates a number higher than expected, this seems to be more appropriate. Furthermore, the term accessory may lead to the belief that the connection of vessels does not bring ischemic risk to the renal parenchyma, which is not true (FRANCISCO and SAMPAIO, 1992; ALONSO and ABIDU-FIGUEIREDO, 2008).

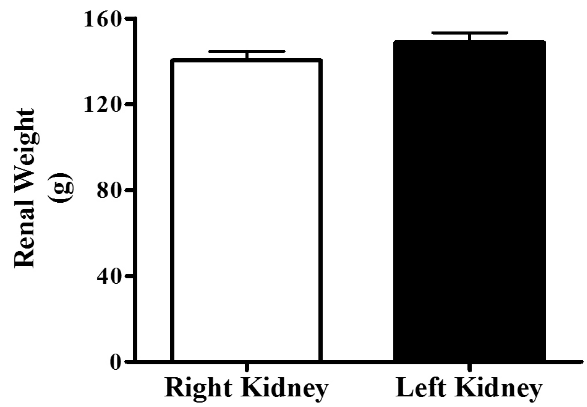

Figure 1. Average weight of kidneys.

Figure 2. Afferent renal artery as first branch of main renal artery.

Figure 3. Afferent renal artery with insertion in the lower pole of the kidney.

Table 1. Data of weight and presence of anatomical variations.

	Weight (g)	Variation		Percentage of variation (%)
		Higher pole	Lower pole	
Right kidney	140,4 ± 22,6	10	1	40
Left kidney	148,8 ± 20,5	6	1	35

In cases with more than one artery coming directly from the aorta, the smaller one behaves like a segmental artery (GRAVES, 1954; FINE and KEEN, 1966; LONGIA, KUMAR and GUPTA, 1984). In one study (BUSATO JÚNIOR and RIBAS FILHO, 2003), two kidneys with more than one renal artery were found among 30 analyzed. In one case, the renal artery nourished the posterior lower renal segment, with more of a caudal emergency from the aorta. In another case, a small-caliber artery, also more caudal, assumed the role of the lower branch segmentary. In this analysis, a different result was obtained: the supernumerary renal artery was more frequent in the upper pole (most cranial). In 11 kidneys rights that had more than one renal artery, the accessory artery (smaller in diameter compared with the main renal artery) irrigated the upper pole in 10 samples. In 7 left kidneys, the aberrant renal artery irrigated the upper pole in 6 of them.

Even when 3 arteries derived directly from the aorta, the smaller arteries behave as segmentary branches of the kidney artery. Both the arteries most cranial and caudal are smaller, the first one acts similarly to the apical artery and, the other, as the lower segmentary. This pattern has been reported by other authors in situations with more than two arteries (GRAVES, 1954; REIS and ESENTHER, 1959; VERMA, CHATURNEDI and PATHAK, 1961; LONGIA, KUMAR and GUPTA, 1984). In the present analysis kidneys with more than two renal arteries were not found.

In a review of the mapping value of the Doppler Velocimetry (Doppler) of the fetal renal artery the kidneys are supplied by the single main renal artery, which originates from the abdominal aorta immediately below the origin of the superior mesenteric artery. The main renal arteries follow their corresponding vein, being the right renal artery the one which passes after the inferior cava vein. In 20% of the kidneys, supernumerary renal arteries may occur, which usually originate near the origin of the main renal artery, and may be above or below this artery, and is usually smaller than it.

Therefore, in general, the studies showed prevalence of more than one renal artery up to 50% of the series examined (PICK and ANSON, 1940; ANSON and DASELER, 1961; HARRISON, FLYE and SEIGLER, 1978; AWOJOBI, OGUNBIYI and NKPOSONG, 1983), which is in accordance with the present study; it has found that 40% for right kidneys and 35% for left kidneys. However, there are studies that show the presence of an artery in 10% of the kidneys. This is due to stricter criteria to consider as renal artery, excluding vessels that depart from the main trunk of renal artery, other vessels like gonadal, mesenteric or polar vessels where there was a segmentary artery to the same segment of the kidney (SIMON, KUPERMAN and SIMON 1968).

4 Conclusion

Based on the findings of the samples examined, we have found that the supernumerary renal artery, when present, had greater relationship with the kidney upper pole especially the right kidney. Additionally, we have not found significant difference between the kidney weights when both kidneys were compared to each other.

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