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SHORT REPORT

Two Accessory Renal Arteries With Histological Properties

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Kidneys are mainly (70 %) supplied by renal arteries (RA) diverging from the aorta. Numerical and locational variations of these arteries can be seen during dissections or angiographies (1-5). Existence of an additional artery is the most frequent variation of the kidneys (25-30 %). These arteries are called accessory or supernumerary renal arteries (ARA) (1, 4-8). Frequency of one, two and more ARA is reported as 17.6 %, 2.3 % and 1 % respectively (9).

In the present study, native renal arteries, supernumerary renal arteries and anterior inferior segmental arteries (AISA) of two cadavers are presented with histological properties such as lamina elastica interna discontinuity, intimal hyperplasia and tunica media thickness, as these properties were not mentioned in the literature about the variations of these vessels.

Case Reports

During the dissection of an 81 year-old male cadaver, we encountered a kidney with two arteries and two veins on the right side. The renal artery emerged from the lateral side of the abdominal aorta at the second lumbar vertebra level and reached the hilum of the kidney after passing behind Inferior Vena Cava (IVC). It was 66 mm in length and 6.6 mm in diameter. The other artery; ARA emerged from the anterior surface of the abdominal aorta, 17 mm distal to the RA. After crossing IVC and ureter in front, it reached the lower pole near the hilum of the kidney. The length of the ARA was 52 mm, and the diameter was 2.3 mm at the beginning and 4.8 mm at the distal end (Figure 1).

One of the veins was 32 mm and the other, lying behind it, was 41 mm in length. The first mentioned was behind the anterior superior and inferior segmental artery and in front of the other segmental arteries. The latter vein was behind all the vessels at the hilum of the kidney. The distance between these two veins was 11 mm on joining IVC (Figure 1).

Dimensions of the right kidney were 85.1x45.7x45 mm with normal shape, size and location. The left kidney was also in normal shape, size and location and its dimensions were 88x49x42 mm. The RA, renal vein (RV), testicular artery (TA) and testicular vein (TV) falloved their normal courses.

The other case was a 38 year-old female cadaver. The RA of the right kidney emerged from the aorta at the second lumbar vertebra level and was 65 mm in length and 5.5 mm in diameter. It passed behind the IVC before reaching the hilum of the kidney. The ARA emerged from the anterolateral surface of the aorta, 54 mm distal to the RA. This artery reached the kidney at the lower pole.

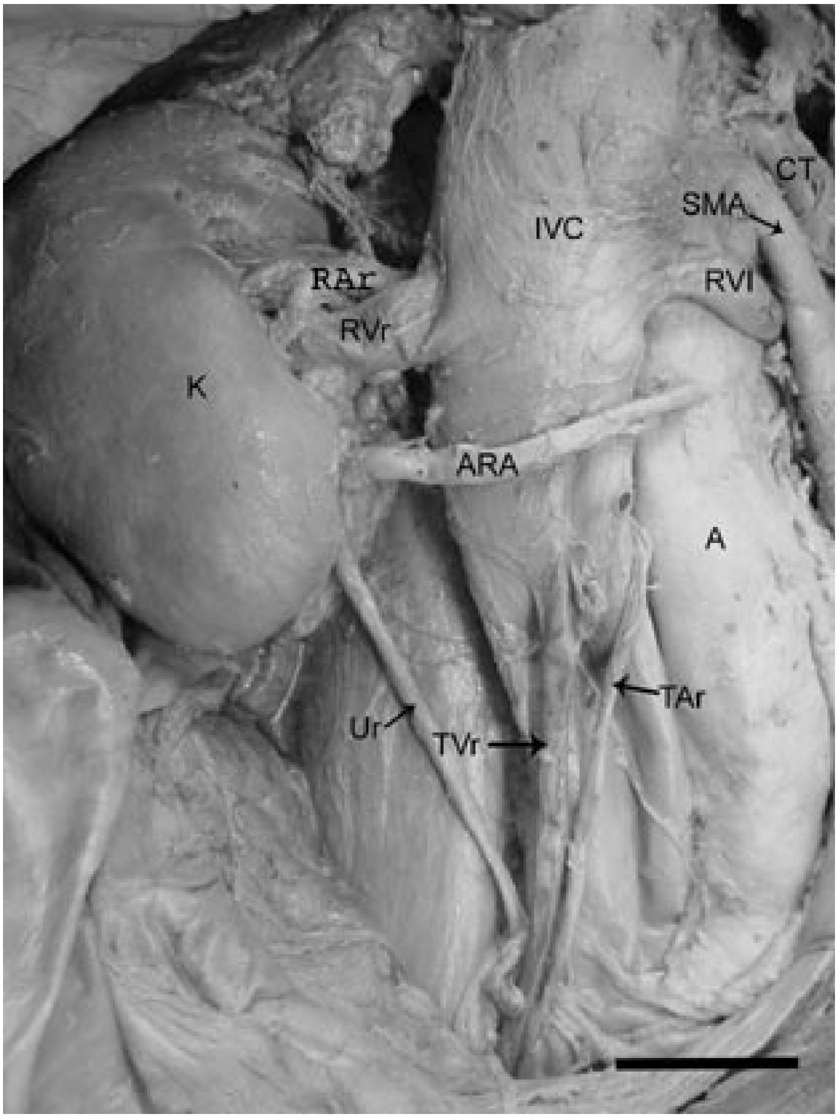

Figure 1. Photograph showing the accessory renal artery of the male cadaver (scale bar = 25 mm).
ARA: accessory renal artery, A: aorta, CT: celiac trunk, SMA: superior mesenteric artery, IVC: inferior vena cava, K: kidney, RVr: right renal vein, RVl: left renal vein, TVr: right testicular vein, TAr: right testicular artery, Ur: ureter

It was 2.9 mm in diameter and 58 mm in length. The ARA passed in front of the IVC, the ovarian vein and the beginning part of the right ureter. The length of the right kidney was 92.2 mm, and width and thickness were 23x53.6 mm at the upper pole, 55.3x75.4 mm at the lower pole (Figure 2). As the left kidney was removed (without its vessels) for autopsy it was not possible for us to evaluate its dimensions.

A section from the RA (5 mm from aorta), two sections from the ARA (one was 5 mm from the hilum of the kidney and the other was 5 mm from the abdominal aorta), and a section from the AISA (5 mm from the hilum of the kidney) were taken from both cadavers. The sections were routinely processed for light microscopy and embedded in paraffin. Sections (5 mm) were cut by microtome and stained with Verhoeff's method for elastic

Figure 2. Photograph showing the accessory renal artery of the female cadaver (scale bar= 25 mm)
ARA: accessory renal artery, OAr: right ovarian artery, A: aorta, CT: celiac trunk, IMA: inferior mesenteric artery, IVC: inferior vena cava, K: kidney, RVl: left renal vein, RVr: right renal vein, OVr: right ovarian vein. Ur: ureter

fibers to identify the tunica muscularis clearly (10). Slides were examined by an Olympus BX50 light microscope.

One section from the proximal and one section from the distal parts of the ARA and one section from the initial part of each of the other arteries were taken for histopathological evaluation. Mean values of 20 different measurements of each section were taken to examine the thickness of tunica muscularis and values denoted in Tablo 2. Histopathological properties such as; intimal hyperplasia and lamina elastica interna discontinuity were also evaluated for each artery (Table 1, Figure 3). The luminal areas were calculated using the point counting method (11) (Table 3).

Tunica muscularis thickness was less in the proximal part of ARA than the distal part of each cadaver (Table 2).

Intimal hyperplasia, which is a component of the atherosclerosis process, was observed in all arteries of the 81 years old male cadaver, as expected (12,13). On the other hand there was no intimal hyperplasia in the vessels of the 38 years old female cadaver except for the RAl.

Lamina elastica interna discontinuity, which is the onset of the atherosclerosis process, was observed in the AISA and the right RA of the male cadaver (14). Lamina elastica interna discontinuity of the female cadaver was defined in the right RA and the AISA, whereas there was no discontinuity in the ARA and the left RA (Table 1, Figure 3).

Histopathological and anatomic properties of ARA might be important in terms of pathologies like stenosis of renal artery, renovascular hypertension and transplantation (17,18). However, we have encountered no studies concerning the histological properties of accessory renal arteries. The aim of the study was to draw attention to the lack of data about the histopathological properties of ARA, which is a frequent variation.

ARA, which is known to originate from the abdominal aorta normally, is also reported to originate from the inferior phrenic, superior, middle or inferior suprarenal, coeliac trunk, superior or inferior mesenteric, middle sacral, common, internal or external iliac, 2nd or 3th

Table 1. Histological properties of arteries.

Sex	RAr		ARA-p		ARA-d		R-AISA		RAl	
	M	F	M	F	M	F	M	F	M	F
Intimal hyperplasia	+	∅	+	∅	+	∅	+	∅		+
LEI discontinuity	partial discontinuity	∅	∅	∅	∅	∅	partial discontinuit	partial discontinuity		∅

RAr: right renal artery, ARA-p: proximal to accessory renal artery, ARA-d: distal to accessory renal artery, R-AISA: right anterior inferior segmental artery, RAl: left renal artery, M: male, F: female

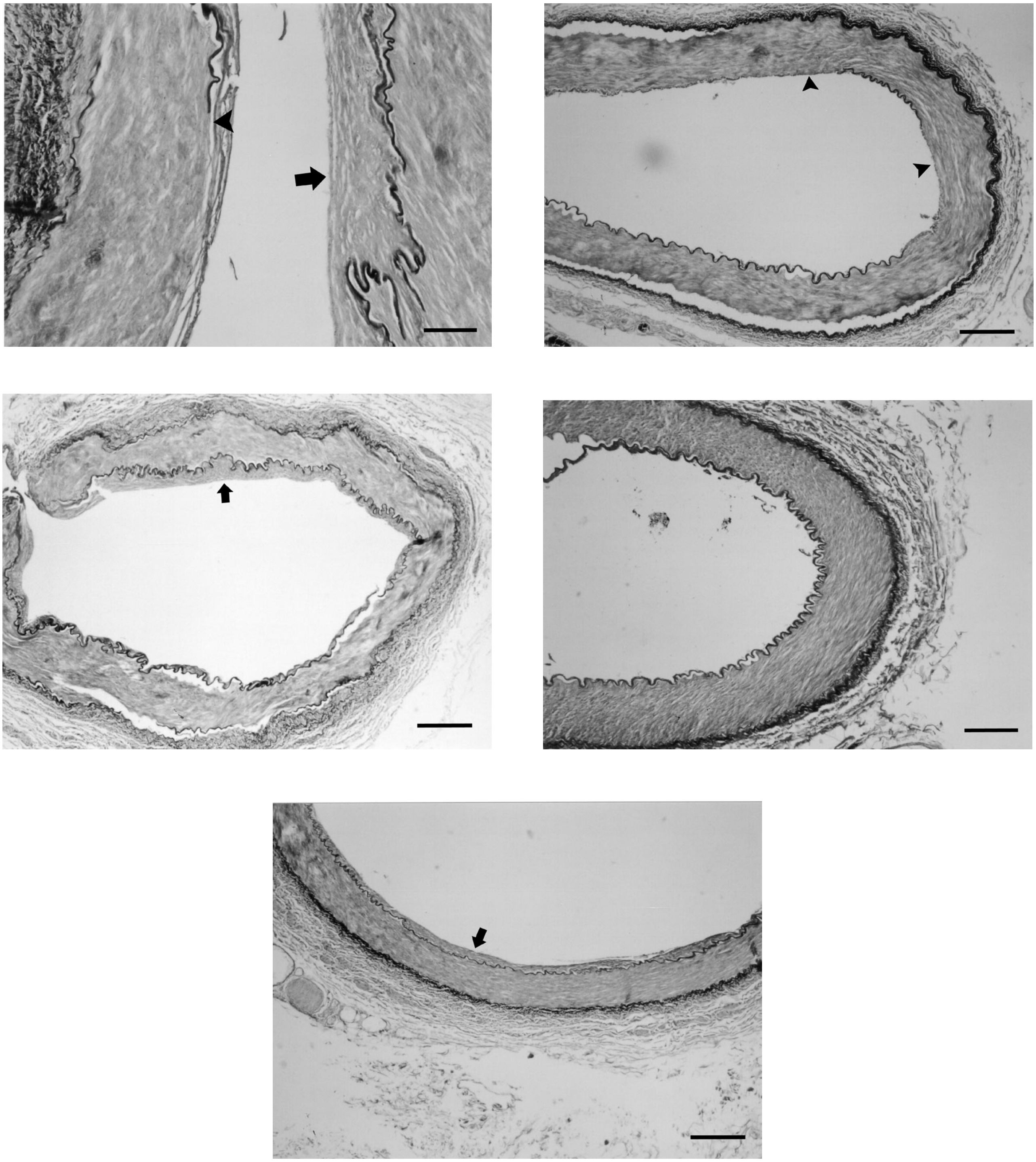

Figure 3. Photograph showing the histological properties of the vessels:
a. RA (M, Verhoeff C 100) (scale bar= 100 mm)
b. AISA (F, Verhoeff C 40) (scale bar= 250 mm)
c .ARA-p (M, Verhoeff C 40) (scale bar= 250 mm)
d. ARA-p (F, Verhoeff C 40) (scale bar= 250 mm)
e. ARA-d (M, Verhoeff C 40) (scale bar= 250 mm)
arrow: intimal hyperplasia, arrowhead: lamina elastica interna discontinuity

Table 2.Tunica muscularis thickness of the arteries (mm).

	Sex	Min	Max	Mean	SD
RAr	M	242	415	322	53.2
	F	295	520	404	66.98
ARA-p	M	82	230	157.2	37.4
	F	145	245	180.1	26.6
ARA-d	M	105	290	193.5	45.2
	F	230	372	296	43.2
R-AISA	M	105	205	156.9	27.96
	F	140	250	222.2	24.5
RAl	M	-	-	-	-
	F	100	395	264.2	87.5

RAr: right renal artery, ARA-p: proximal to accessory renal artery, ARA-d: distal to accessory renal artery, R-AISA: right anterior inferior segmental artery, RAl: left renal artery, M: male, F: female

Table 3. Luminal areas of the arteries.

sex	RAr		ARA-p		ARA-d		R-AISA		RAl	
	M	F	M	F	M	F	M	F	M	F
area (mm^2)	1.76	3.40	1.91	1.10	4.55	2.61	2.61	2.07	-	10.96

RAr: right renal artery, ARA-p: proximal to accessory renal artery, ARA-d: distal to accessory renal artery, R-AISA: right anterior inferior segmental artery, RAl: left renal artery, M: male, F: female

lumbar, spermatic, ovarian, right colic, subcostal, splenic, pancreatic, hepatic or contralateral renal arteries (1,3,4,6,8,9). Developmental anomalies of the kidneys such as rotational anomalies, double kidney, fused kidney, dystrophic kidney are reported to accompany the supernumerary renal arteries and are the underlying causes of their variations (9).

Formation of ARA can be explained in association to the embryological development of the kidneys. The metanephric kidney nascents at sacral levels, and then migrates cranially. So, as the kidney ascends, it is supplied by middle sacral and common iliac arteries, sequentially. As the arteries diverging from the upper levels become dominant, the ones diverging from lower levels degenerate. Inadequacy in this degeneration causes formation of supernumerary renal arteries (1,7,8).

It is known that primitive renal arteries normally regress under the control of some physiological mechanisms (7). Nevertheless, ARA which failed to complete this process might be affected by these mechanisms. Indeed, in the male cadaver, the diameter and tunica muscularis thickness of the proximal part of ARA was less than the distal part. This suggested that a physiological regression period had begun, but somehow could not be completed. In this study, data of only two cases were presented concerning the histopathologic aspect of this morphologic variant. We believe that statistical analysis of a wider adult series, composed of different ages and sexes would explain whether this artery is prone to the pathological changes or not. Thus, lack of an important data would be eliminated from the literature.

Stenosis of ARA and its branches may also cause renal hypertension as well as stenosis of the RA and its branches (17,18). When stenosis in any renal arterial branch occurs, infarction develops in the area supplied by that artery as renal arteries are end-arteries (3,8). As ARA is also endowed with the same property, it can be thought that this artery acts as a segmental artery. The study of Dorffner et al, in which they report that 15-37 % of the total renal mass is perfused only by ARA, confirms this suggestion (2,15). If it is ignored during the application of aortic stent graft or renal arterial transplantation, functional loss would be expected in the region supplied by the ARA (2,16).

ARA is reported to exist in similar frequency at both sides and usually supplies the lower pole of the kidney (1,4,8,15,18). Also the lower polar branches are reported to be wider than the upper polar branches (1). ARA may pass in front of or behind the IVC, but if it supplies the caudal part of the kidney, it usually passes in front of the IVC (8). Evaluation in a in wider series of whether the existence of ARA at the right or left, supplying the upper or the lower pole, and/or passing in front or behind IVC reflects the histological properties or not should be made.

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