Normal morphology of renal vascularization and its related anatomic variations by use of imaging examinations in Albania

Roland Hasa[1], Almir Skana[2]

[1]Orthodox Church Clinic & Hygeia Hospital, Tirana, Albania;
[2]University Hospital Center "Mother Teresa", Tirana, Albania.

Corresponding author: Roland Hasa, MD
Address: Rr. "Dibres", No. 159, Tirana, Albania;
Telephone: +35542360925; Email: roland_hasa@yahoo.com

Abstract

Aim: The aim of our study was to provide an angio-CT evaluation of normal renal vascularization morphology and their anatomic variations in Albanian individuals.
Methods: This study included 100 subjects (52 females and 48 males, overall mean age 57 years) who were examined during February-July 2013. Angio-CT was performed to all individuals. Renal arteries were visualized during arterial phase with intravenous contrast. We evaluated anatomy and origin localization of normal renal arteries including even accessory renal arteries, variations of trajectory and lumen size.
Results: In all cases, the origin of main renal artery was between the upper edge of the T12 vertebra and L2-L3 intervertebral disc. The common origin of renal artery is the level of L1 vertebral body. About 73% of the cases had single renal artery in both kidneys. Conversely, 20% of the cases had unilateral multiple renal arteries, whereas 7% of the cases had bilateral multiple renal arteries. Parahilar division of the renal artery was identified on the right side in 45% of the cases, whereas on the left side it was evident in 45% of the cases. Right accessory renal arteries were found in 18% of the cases and left version in 17% of the cases. The percentage of polar and hilar renal arteries was respectively 18% and 82% of all the accessory renal arteries. The predominant trajectory of renal arteries was horizontal. Mean lumen size resulted 4-6 mm with minimum and maximum size of 1mm and 8 mm, respectively.
Conclusion: In most cases, the origin of renal arteries is in L1 vertebra. Accessory renal arteries were quite frequent in this sample of Albanian individuals. Different subjects had different origin, lumen size and trajectory of renal artery. These findings should be taken into consideration before renal artery microsurgery such as in renal transplantation, in adaptability between donor and receptor, in obstruction of pelvi-uretheric junction, and in renovascular hypertension.

Keywords: anatomic variations, imaging, morphology, radiology, renal vascularization.

Introduction

Variations of origin and variations in the number of renal arteries are explained by mesonephric changes during embryonic development (1). The absence of mesonephric arteries is the cause of the development of more than one renal artery. The main renal artery takes origin from the abdominal aorta, under the superior mesenteric artery, at the level of L1 vertebral body, intervertebral disc L1-L2 and L2 vertebral body (1,2). In connection with the vertebral column, the right main renal artery appears above the left renal artery.

Kidneys need sufficient blood supply in order to perform their important function. In adequate physiological vascularization, the kidneys take 20%-25% of cardiac debit being the most vascularized organs in the body (3,4). Blood flow is closely related to the caliber of the renal arteries. A number of pathologies such as renovascular hypertension are closely related to the reduction of renal blood flow.

In many individuals there are identified numerical variations of renal arteries which are classified into two groups (5,6): *i) early division renal arteries* (renal trunk division into two or more branches before its entry into renal hilus). Early divisions of renal arteries are anatomical variations where the renal arterial trunk is divided into two or three branches before the entry in renal. There are two groups of early divisions: hilar artery (accessory) and polar artery (aberrant); *ii) multiple renal arteries* (presence of more than one renal artery). The origin level of the renal artery may be at different levels of the abdominal aorta or other intra-abdominal arteries. Right renal artery is longer than the left one and passes through the inferior vena cava, right renal vein, the head of pancreas and the descending part of the duodenum. In turn, the left renal artery is positioned behind the left renal vein, body of pancreas and is intersected by veins lienal and inferior mesenteric vein. Each artery is divided into four or five branches before entering the kidney, in the renal hilus. They lie mostly between the hilus the renal vein and urethra (7,8). Yet, this classification between early division renal arteries and multiple renal arteries is only theoretical because the coexistence of renal artery and its early division is quite frequent (9,10).

The evidence from Albania regarding the normal morphology of renal vascularization and its related anatomic variations is scarce. The aim of our study was to provide an angio-CT evaluation of normal renal vascularization morphology and their anatomic variations in Albanian individuals.

Methods

This study included 100 subjects (52 females and 48 males, overall mean age 57 years) who were examined during February-July 2013.

All patients completed the informed consent form after being explained the aim and procedures of the study. Angio CT was performed in all cases. Renal arteries were visualized during artery with intravenous contrast. There was no need for extra procedures. We evaluated the anatomy and origin localization of normal renal arteries including even accessory renal arteries, variations of trajectory and of lumen size. Patients with renal pathologies were excluded. Mean age of the patients 57.6 years (range: 16- 85 years). There were 48 males (48%) and 52 females (58%). Diagnostic accuracy of renal vascularization angio-CT depends on the initial scan data. The correct preparation, position and contrast injection are crucial in this regard. CT protocol for assessing renal vasculature consists of two phases, with contrast and without contrast.

Optimal anatomical scan in arterial phase of MDCT should include the area between the celiac trunk and the bottom part of iliac commune artery. Modification is needed in cases of ectopic or transplanted kidney.

CT scan examination was performed with 64-detector scan MDCT (Siemens, Germany).

Contrast injection protocol: 1-1.5 mm thick cross section are obtained after rapid injection of

contrast bolus Iomeron 100 ml with concentration of 300-400 mg / 100 ml at a speed of 4 cc / sec in the scanner with 64 - detector MDCT. The image is taken after a delay of 4-5 seconds in 64-detector MDCT scanner, when the threshold of 100 HU was achieved in the region of interest located in the abdominal aorta (5,6). Cross sections of 5 mm were used for evaluation of renal vascular structures and abdominal organs. In cases with suspicious mass gland, it was used a 10-15 min delayed scanning.

Technical processing (5,6):

• Axial images remain the basis for the diagnosis, but the reshaped images contribute to more accurate assessment. Technical processings most commonly used are Multiplane and curved plane Reshaping (MPR, CPR), maximum intensity projection (MIP) and volume rendering (VR).

• Provided angiographic images (PIM) makes an excellent recording of the vascular anatomy and different variations in different projections for the correct interpretation of stenotic lesions.

• MPR and CPR images are particularly useful for accurately assessment of arterial lumen diameter, for accurate determination of arterial stenosis.

• VR images can be used for screening of the abdominal vasculature. Finally, axial images should always be reviewed for possible presence of a non-associated vascular pathology

We prospectively studied the number of renal arteries on both sides, the presence of accessory or aberrant renal arteries, as well as the level of the origin of the renal artery, their direction and the lumen size.

Results

In all cases, the origin of main renal artery was between the upper edge of the T12 vertebra and L2-L3 intervertebral disc. The common origin of renal artery is the level of L1 vertebral body. The distribution of selected characteristics o the patients included in this study is presented in Table 1. About 73% of the cases had single renal artery in both kidneys. Conversely, 20% of the cases had unilateral multiple renal arteries, whereas 7% of the cases had bilateral multiple renal arteries. Parahilar division of the renal artery was identified on the right side in 45% of the cases, whereas on the left side it was evident in 45% of the cases. Right accessory renal arteries were found in 18% of the cases and left version in 17% of the cases. The percentage of polar and hilar renal arteries was respectively 18% and 82% of all the accessory renal arteries. The predominant trajectory of renal arteries was horizontal. Mean lumen size resulted 4-6 mm with minimum and maximum size of 1mm and 8 mm, respectively. Parahilar division arteries were present in 45% of the subjects, where 70% of them were bilateral and 30% were unilateral. There was no significant difference between early divisions of the left and the right renal arteries. Overall, 93% of parahilar arteries were hilar (accessory) and 7% were polar arteries (aberrant).On the whole, 75% of the subjects resulted with the same origin level of bilateral renal artery origin at the L1 vertebral body and in 25% of the cases it resulted with different origin levels, mainly at the level of the interval T12-L1.In 27% of the patients there was evidence of multiple arteries (Table 1).

Table 1. Distribution of selected characteristics of the study population (N=100)

CHARACTERISTIC	Number	Percentage
Type of artery:		
Single renal artery	73	73%
Unilateral multiple artery	20	20%
Bilateral multiple artery	7	7%
Origin level:		
L1	75	75%
T12-L1	25	25%
Presence of parahilar arteries:		
Yes	45	45%
No	55	55%
Type of parahilar arteries:		
hilar (accessory)	93	93%
polar (aberrant)	7	7%
Multiple arteries:		
Yes	27	27%
No	73	73%

Variations with multiple renal arteries were unilateral in 20% of individuals and bilateral in 7% of the subjects. On the other hand, 18% of the cases resulted with right multiple renal arteries and 17% resulted with left multiple renal arteries. About 82% of all accessory renal arteries were hilar renal arteries, and 18% were polar renal arteries. There was a significant predominance of multiple renal arteries among males. Most of them were in the right kidney.

Discussion

Comparing our study with other similar studies on renal vascularization (4), we obtained a smaller number of cases with accessory renal artery (supranumerale): respectively 12.5% versus 26-30%, i.e., about 50% less than OPUS II. In our study, there was no significant difference between cases with left and right accessory renal arteries, whereas in Opus II the presence of left accessory renal arteries dominated significantly (4). Single renal artery was identified in 73% of the cases in our study, while the Opus II reported 72%. In turn, double/triple renal arteries were identified respectively in 17%/0.5% in our study versus 11%/1.7% in Opus II (4). Opus II described the presence of a renal artery on one side and some on the other side. This was not uncommon in our study, where we found a combination in 20% of the cases. Opus II found no predominance of sex variation in supranumerale arteries, whereas in our study accessory arteries were predominant in males. These data suggest that our sample may be similar to the general population in terms of incidence of anatomic variations and the presence of accessory arteries. Nevertheless, there are some specific typical variations, which should be taken into consideration during surgical procedures in the Albanian population. Comparing our data with a previous study (11), we found a correlation between the length of the renal artery and the origin level of the renal arteries. In our study, the L1 vertebral body predominated as the origin of renal arteries, while in another study it was evidenced the intervertebral disc level L1-L2 (11). The diameter of the renal arteries in our study was smaller compared to this other study (11).

Furthermore, we found a correlation regarding the parahilar early division (two or three branches), and

the entry of the renal artery in renal hilus. In a Turkish study that included 855 individuals, there was reported a significant correlation of normal morphology and its variations (7). This study concluded that the morphology of renal vascularization and its variations are closely related to race (7).

In our study, the main renal artery rouse at the L1 vertebral body in 50% of the cases, whereas for the remaining 50% of the cases it was in other vertebral levels; this was between the lower edge of the T12 vertebra and intervertebral disc L2-L3. In our study, 49% and 53% of the origin renal arteries was at the L1 vertebral body, on the right and left side, respectively. In our study, the origin of the renal artery leading from L1-L2 intervertebral disc was 26% on the right side and 27% on the left side.

Early divisions show variations based on social affiliation, ethnicity and race (12). Satyapal et al. stated that the frequency of early divisions is between 9% and 76% (28% on the average) (10). Early division was 45% in our study which is consistent with other studies (9,10). In our study, the frequency of early bilateral division was 7%. We found multiple arteries in approximately 17.5% of individuals; bilaterally in 7% of individuals; and unilateral in 20% of cases. Their origin was mainly at the level of L2 vertebra. Our study showed that mean diameter of renal artery varied from 4-6 mm with a minimum of 1 mm and a maximum of 8 mm. Also, 63% of individuals had a horizontal trajectory of renal artery.

In conclusion, findings of this study should be taken into consideration before renal artery microsurgery such as in renal transplantation, in adaptability between donor and receptor, in obstruction of pelvi-uretheric junction, and in renovascular hypertension.

Conflicts of interest: None declared.

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