Gac Méd Caracas 2022;130(3):545-554
DOI: 10.47307/GMC.2022.130.3.9

Features of blood supply to the human kidney with a five-segment concept of its structure

Características del suministro de sangre al riñón humano con un concepto de cinco segmentos de su estructura

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SUMMARY

The purpose of the research was a study of sources of blood supply to the segments of the kidney in the most common variant of the branching of the renal artery and its branches. The material for the study was 116 corrosive preparations of the arterial system of the human kidney, made of fast-hardening polymers. These preparations were subsequently subjected to 3D scanning and topographic and anatomical analysis. When studying 116 3D models of the arterial bed of the human kidney, the most common variant of the division of A. renalis (I) into ventral and dorsal branches was identified (54.3 %, 63/116). Subsequently, the most common type of intra-organ branching of the arteries of the 2nd and 3rd orders was established (46 %, 29/63) when the ventral artery of the 2nd order branched according to the dispersal type, and the dorsal one branched according to the magistral one. In the selected group of 29 preparations of arterial vessels of the human kidney, the level organization of the links of the renal arteries was systematized according to which the segmental arteries corresponded to the interlobar arteries (III), the number of which averaged 7±1. The analysis found that pools on average (X±m) from 1 to 3 segmental arteries can be distributed in one segment of the kidney, with p ≤ 0.05. In the course of comparing the results of this study with the generally accepted concept of a five-segment structure of the kidney, it was found that in the studied group of kidneys, the blood supply to the upper anterior, lower anterior, and posterior segments is carried out through the 1st segmental artery, originating from the ventral artery system (II) on the way to upper anterior and lower anterior segments and from the dorsal artery (II) on the way to the posterior segment. The pole segments had different variants of blood supply. Most often, the upper pole segment was supplied with blood by the 1st segmental artery, extending from A. ventralis (II) (41.2 %), less often by the 1st segmental artery extending from A. renalis (I) (21.2 %) or A. dorsalis (II) (5.3 %). The inferior pole segment was also predominantly supplied with blood by the 1st segmental artery from A. ventralis (II) (68.3 %), less often through the 1st segmental artery extending from A. renalis (I)

DOI: https://doi.org/10.47307/GMC.2022.130.3.9

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Recibido: 6 de mayo 2022
Aceptado: 28 de agosto 2022

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(4.3 %). Several sources of blood supply to the pole segments (from the system of the ventral and dorsal arteries) were found in 32.3 % of cases for the upper pole segment and 27.4 % of cases for the lower pole segment. As a result of the study, it was concluded that the variational anatomy of the kidney segments was determined primarily by the division of the main renal artery (di- or trichotomic division variant), as well as the type of branching of its intra-organ branches (magistral or dispersal type).

Keywords: *Kidney, renal artery, segment of the kidney, 3D modeling.*

RESUMEN

El objetivo de la investigación fue un estudio de las fuentes de suministro de sangre a los segmentos del riñón en la variante más común de la ramificación de la arteria renal y sus ramas. El material para el estudio fueron 116 preparaciones corrosivas del sistema arterial del riñón humano, hechas de polímeros de endurecimiento rápido. Estas preparaciones fueron posteriormente sometidas a escaneo 3D y análisis topográfico y anatómico. Al estudiar 116 modelos 3D del lecho arterial del riñón humano, se identificó la variante más común de la división de A. renalis (I) en ramas ventral y dorsal (54,3 %, 63/116). Posteriormente, se estableció el tipo más frecuente de ramificación intraórgano de las arterias de 2° y 3° orden (46 %, 29/63) cuando la arteria ventral de 2° orden se ramificaba según el tipo de dispersión, y la dorsal se ramificaba según el tipo de dispersión, de acuerdo con la magistral. En el grupo seleccionado de 29 preparaciones de vasos arteriales del riñón humano, se sistematizó la organización a nivel de los enlaces de las arterias renales según la cual las arterias segmentarias correspondían a las arterias interlobulares (III), cuyo número promediaba 7±1. El análisis encontró que los conjuntos en promedio (X±m) de 1 a 3 arterias segmentarias pueden distribuirse en un segmento del riñón, con p ≤ 0,05. En el curso de la comparación de los resultados de este estudio con el concepto generalmente aceptado de una estructura de cinco segmentos del riñón, se encontró que en el grupo estudiado de riñones, el suministro de sangre a los segmentos anterior superior, inferior anterior y posterior se realiza a través de la 1.ª arteria segmentaria, que se origina en el sistema arterial ventral (II) en su trayecto hacia los segmentos anterior superior e inferior anterior y en la arteria dorsal (II) en su trayecto hacia el segmento posterior. Los segmentos polares tenían diferentes variantes de suministro de sangre. Con mayor frecuencia, el segmento del polo superior recibió sangre de la 1.ª arteria segmentaria, que se extiende desde A. ventralis (II) (41,2 %), con menor frecuencia de la 1.ª arteria segmentaria que se extiende desde A. renalis (I) (21,2 %) o A. dorsalis (II) (5,3 %). El segmento del polo inferior también estaba predominantemente irrigado por la primera arteria segmentaria de A. ventralis (II) (68,3 %), con menos frecuencia a través de la primera arteria segmentaria que se extiende desde A. renalis (I) (4,3 %). Se encontraron varias fuentes de suministro de sangre a los segmentos del polo (desde el sistema de las arterias ventral y dorsal) en el 32,3 % de los casos para el segmento del polo superior y en el 27,4 % de los casos para el segmento del polo inferior. Como resultado del estudio, se concluyó que la anatomía variacional de los segmentos renales estuvo determinada principalmente por la división de la arteria renal principal (variante de división di- o tricotómica), así como el tipo de ramificación de sus ramas intra-órgano (tipo magistral o de dispersión).

Palabras clave: *Riñón, arteria renal, segmento de riñón, modelado 3D.*

INTRODUCTION

Improving the methods of imaging diagnostics, as well as their availability in clinical practice, contributed to an increase in the frequency of detection of various pathological processes in the kidneys, including neoplastic ones (1, 2). Particularly favorable is the fact that most kidney tumors are diagnosed at their early stages (3, 4).

Detection of tumors at stage T1 provides an opportunity for organ-preserving surgical interventions (5, 6). According to the European Association of Urology, partial nephrectomy is the treatment of choice for localized kidney tumors <7 cm (7). The advantage of resections in comparison with complete nephrectomy is the ability to preserve the functional activity of the kidney, with the same efficiency of control of the neoplastic process (8, 9), especially because since 1990, there has been a twofold increase in the incidence of kidney cancer (10).

Segmental resections are a type of organ-preserving treatment of pathological processes in the kidneys, which requires a detailed understanding of the topographic and anatomical features of the relationship between the pathological formation and the structures of the kidney, especially with the renal vessels, to ensure high-quality intraoperative hemostasis (11,12). In addition, a promising method for reducing warm ischemia during kidney surgery is the imposition of clamps not on the main trunk of the renal artery but its segmental branches. Shao et al. (13) point to the success of using this technique in 82 patients, subject to a mandatory preoperative 3D reconstruction of the renal vessels and preoperative determination of access to the target segmental artery.

In Russia, many volumetric modeling techniques have been developed for preoperative planning. For example, Alyaev et al. (14) developed a technique that makes it possible to visualize the volume of pathological involvement in kidney tumors by combining the arterial, parenchymal, venous, and excretory phases on one integral image with CT scanning. In another study, Glybochko et al. (15) developed a technique that allows for virtual removal/section of the tumor, followed by obtaining information about the structures of the fundus and the plane of kidney resection (the presence of large segmental vessels and elements of the pyelocaliceal system).

The above data indicate the importance of knowing the features of the intraorgan architectonics of the vascular system of the kidney. However, an increasing number of studies, including those previously published by us (16), cast doubt on the concept of a five-segment structure of the human kidney, accepted in world practice, in which each renal segment is supplied with blood by its own segmental branch (9). Initially, the upper (pole), upper anterior, lower anterior, posterior, and lower (pole) segments are distinguished (17, 18). Borojeniet et al. (9) indicate that the generally accepted angioarchitectonics of the kidney was detected only in 42 % of cases (n=25/60). In another study by Macchi et al. (19), the classical branching variant was found in 13 % of cases (n=2/15).

The presence of variations in the morphological structure of the renal vessels leads to the need for a detailed study of the angioarchitectonics of the kidney. Particularly acute is the issue of understanding the sources of blood supply to the segments of the kidney, as well as the topographic and anatomical features of the origin and branching of segmental arteries (20,21).

This research aimed to study the sources of blood supply to the segments of the kidney in the most common variant of the branching of the renal artery and its branches.

MATERIALS AND METHODS

The study was conducted based on the A.A. Kadyrov Chechen State University (Russia) from 2020 to 2022 within the framework of the RFBR grant No. 20-315-90008/20.

The study included the following steps:

1) Acquisition of 116 corrosive preparations of the human kidney arterial system (CPHKAS) within the framework of the RFBR grant No. 20-315-90008/20.

2) CPHKAS were coated with protacryl and barium lead to making them X-ray positive.

3) CPHKAS were photographed with Sony digital camera (Japan).

4) CPHKAS were subjected to 3D scanning using a 3Dl microcomputer tomography system RayScan 130 (Germany).

5) The computer program Mimics 8." (Materialise NV, Belgium) was used for 3D modeling of the arterial vessels of the kidney.

6) A database was created containing the obtained digital material and data from instrumental research methods.

7) Topographic and anatomical analysis of 3D CPHKAS models was performed, including the following steps: 1. determination of quantitative variants of division in A. renalis (I) into daughter branches of the second order; 2. establishment of qualitative variants of division in A. renalis (I) into daughter branches of the second order relative to the kidney anatomical cavities; 3. selection for subsequent analysis of the most numerous groups of CPHKAS; 4. determination of options for division in A. renalis (I) of the 2nd order artery relative to the hilum of the kidney in the selected CPHKAS group; 5. selection for subsequent analysis of the most common type of intraorgan branching of the 2nd and 3rd order arteries according to previous studies (22) with the determination of the frequency of detection of this type of intraorgan

branching in the 2nd and 3rd order arteries in men and women, on the right and left sides; 6. systematization of the level organization of the links in renal arteries in the selected group of CPHKAS; 7. counting the number of the 3rd and 4th order vessels in accordance with the established level organization of the links in renal arteries, as well as the determination of segmental arteries and their number; 8. analysis of the sources of blood supply to the segments of the kidney according to the generally accepted five-segment concept of the kidney structure.

8) Variational statistics of the obtained results were carried out on the Windows 7 platform (Microsoft, USA) with an Intel Core2Duo T5250 1.5 GHz processor, RAM up to 2 GB (Intel, USA). The Excel package Microsoft Office 2007 (Microsoft, USA) was used for calculations.

RESULTS

Topographic and anatomical analysis of 116 CPHKAS 3D models established:

1) two variants of the division of A. renalis (I) into daughter branches of the 2nd order: in the 1st variant, A. renalis branched into two branches (81 preparations, 70 %), and in the 2nd variant into three branches (35 preparations, 30 %).

2) two varieties of the division of A. renalis into two branches: 1. A. renalis branched against the frontal plane into ventral and dorsal branches (63 preparations, 54.3 %) (Figure 1); 2. A. renalis branched against the horizontal plane into superior polar and inferior polar branches (18 preparations, 15.5 %) (Figure 2).

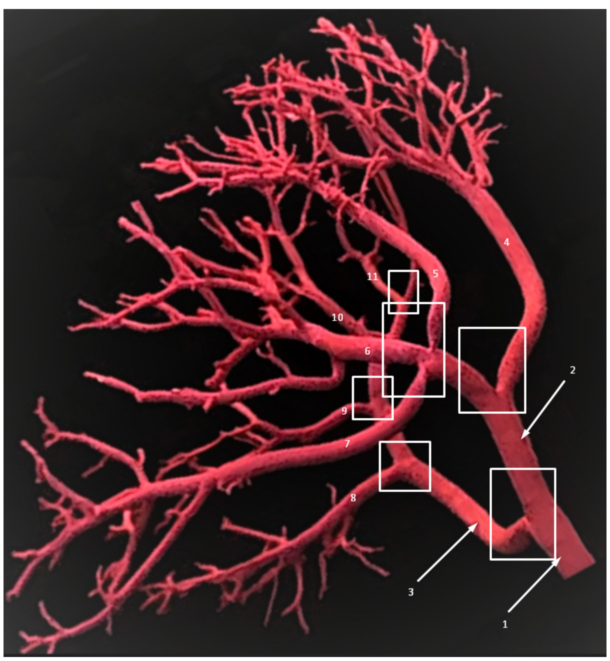

Figure 1. Corrosive preparation of the arterial vessels of the kidney (female, 54 years old): 1) renal artery; 2) ventral artery; 3) dorsal artery; 4-10) segmental arteries

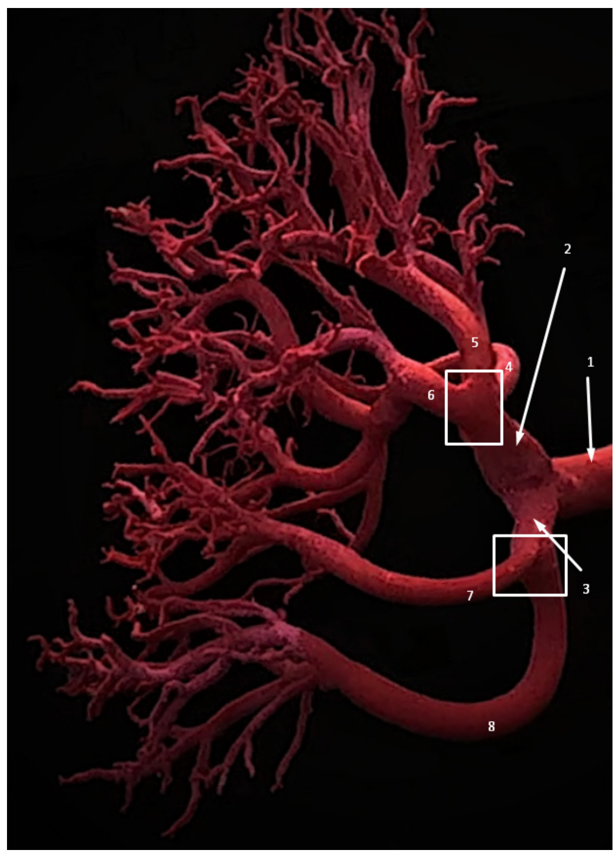

Figure 2. Corrosive preparation of the arterial vessels of the kidney (male, 32 years old): 1) renal artery; 2) superior pole artery; 3) lower polar artery; 4-8) segmental arteries.

2.1) four varieties of the division of A. renalis into three branches: 1. A. renalis branched against the frontal and horizontal plane into ventral, dorsal and superior polar branches (15 preparations, 12.9 %); 2. A. renalis branched against the frontal and horizontal plane into ventral, dorsal, and inferior polar branches (11 preparations, 9.5 %); 3. A. renalis branched against the frontal planes into two ventral and one dorsal branch (6 preparations, 5.1 %); 4. A. renalis branched into the superior polar, central, and inferior polar branches (3 preparations, 2.5 %).

3) for subsequent topographic and anatomical analysis, the most numerous groups of CPHKAS were selected (63 preparations, 54.3 %), in which A. renalis branched into ventral and dorsal branches against the frontal plane.

4) In the selected CPHKAS group (n=63), two types of division of A. renalis (I) into ventral and dorsal branches (II) against the kidney hilum were established: in the 1st variant, A. renalis branched at the kidney hilum, i.e., intrarenally (19 preparations out of 63, 30 %); and in the 2nd variant, at a distance from the kidney hilum, i.e. extrarenally (44 preparations out of 63,70 %).

5) for subsequent topographic and anatomical analysis, according to previous studies (22), out of 63 preparations with division variant A. renalis (I) to the ventral and dorsal branches (II), a group of CPHKAS with the most common type of intra-organ branching of the arteries of the 2nd and 3rd orders (29 preparations, 46.2 %), when the ventral artery of the 2nd order branched in a loose type on average into (X±m) 4±1 arteries of the 3rd order, and the dorsal one according to the magistral type on average into (X±m) 3±1 artery of the 3rd order.

This type of intra-organ branching of the arteries of the 2nd and 3rd order was found in the right kidney in 7.3 % of men and 4.5 % of women and the left kidney in 6.2 % of men and 5.4 % of women, with $p < 0.05$.

6) In the selected group of 29 preparations of CPHKAS, the level organization of the links of the renal arteries was systematized (Figure 3): the 1st link being A. renalis and the 2nd link the zonal arteries (A. ventralis and A. dorsalis). The system of each zonal artery had its own branching characteristics in accordance with the CPHKAS group selected and described in paragraph 5. The ventral artery (II) had a dispersal type of branching and was divided on average into (X±m) 4±1 arteries of the 3rd link, A. interlobares – 1 (III), which were distributed in the parenchyma of the ventral half of the kidney and the area of its poles. Subsequently, each of the A. interlobares – 1 coming from A. ventralis branched on average into (X±m) 2±1 artery of the 4th link, A. interlobares – 2 (IV), which in turn were divided into arcuate arteries of the 5th link in the cortico-medullary zone, A. arcuatae (V). Interlobular arteries of the 6th link, A. interlobulares (VI), diverged from the arcuate arteries (V) into the cortical substance of the kidney.

The dorsal zonal artery (II) had a magistral type of branching and was divided in the parenchyma of the central zone of the dorsal half of the kidney into an average of (X±m) 3±1 artery of the 3rd link, A. interlobares – 1 (III), which in turn branched in the cortico-medullary zone into arcuate arteries, A. arcuatae (IV). Interlobular arteries, A. interlobulares (V), branched off from the arteries of the 4th link in the cortical substance of the kidney.

Summing up, the level organization of the links in the renal arteries can be systematized as follows: with a loose type of branching, the hierarchy of the renal artery is represented by six links – A. renalis (I), A. zonal (II), A. interlobares – 1 (III), A interlobares – 2 (IV), A. arcuatae (V), and A. interlobulares (VI) and with the magistral type – five links – A. renalis (I), A. zonal (II), A. interlobares (III), A. arcuatae (IV), and A. interlobulares (V).

7) In total, when A. renalis (I) branched into ventral and dorsal branches (II) with dispersal and magistral type of branching, the number of vessels of the 3rd order (III) averaged (X±m) 7±1, and of the 4th order (IV), (X±m) 12±2. From the presented data it can be concluded that the segmental arteries are A. interlobares – 1 (III), the number of which is on average (X±m) 7±1. The analysis found that pools on average (X±m) from 1 to 3 segmental

arteries can be distributed in one segment of the kidney, at $p \leq 0.05$.

1st link	A. renalis	
2nd link	A. ventralis ↓ dispersal branching type ↓	A. dorsalis ↓ magistral branching type ↓
3rd link	A. interlobares – 1 ↓	A. interlobares – 1 ↓
4th link	A. interlobares – 2 ↓	A. arcuatae ↓
5th link	A. arcuatae ↓	A. interlobulares
6th link	A. interlobulares	

Figure 3. Level organization of renal artery links.

8) Subsequently, the sources of blood supply to the kidney segments were analyzed according to the generally accepted five-segment concept of the kidney structure. In the studied group of preparations of arterial vessels of the human kidney (29 preparations), four variants of blood supply of the superior polar segment and three variants of blood supply of the inferior polar segment, according to the 1st variant of blood supply of the superior-anterior, inferior-anterior, and posterior segments were identified (Table 1). The blood supply of the superior and inferior anterior segments involved the 1st segmental artery, A. interlobares – 1 (III), which originated from A. ventralis (II). Blood supply to the posterior segment was carried out through the 1st segmental artery, A. interlobares – 1 (III), branching off from A. dorsalis (II).

Table 1

Variant anatomy of blood supply sources of five kidney segments

Segments	Sources of segmental arteries
Superior polar segment	Variant 1: ventral artery system (41.2 %). Variant 2: ventral and dorsal artery system (32.3 %). Variant 3: the system of the main renal artery (21.2 %). Variant 4: dorsal artery system (5.3 %).
Superior-anterior segment	ventral artery system (100 %)
Inferior-anterior segment	ventral artery system (100 %)
Posterior segment	dorsal artery system (100 %)
Inferior polar segment	Variant 1: ventral artery system (68.3 %). Variant 2: the ventral and dorsal artery system (27.4 %). Variant 3: the system of the main renal artery (4.3 %).

Blood supply variants for the superior polar segment

In the studied group of preparations of arterial vessels of the human kidney (29 preparations), where the ventral artery branches according to the dispersal type, and the dorsal artery branches according to the magistral type, four variants of blood supply to the superior polar segment were identified (Table 2). In the 1st variant (41.2 % of cases, with $p < 0.05$), the blood supply to the superior polar segment was carried out by the 1st segmental artery, A. interlobares – 1 (III), branching from A. ventralis (II). The presented interlobular artery branched mainly in the ventral half of the superior pole of the kidney and to a lesser extent in the dorsal half. In the 2nd variant (32.3 % of cases, with $p < 0.05$), two segmental arteries participated in the blood supply of the superior polar segment, one of which branched from A. ventralis (II), and the other one from A. dorsalis (II). In the presented type A. interlobares – 1 (III) formed two halves of the blood supply of the superior polar segment, the ventral and dorsal ones, respectively. In the 3rd variant (21.2 % of cases, with $p < 0.05$), the blood supply to the superior polar segment was carried out by the 1st segmental artery branching from A. renalis (I). In the 4th variant (5.3 % of cases, with $p < 0.05$), the blood supply of the segment was performed through the 1st segmental artery branching from A. dorsalis (II). The presented interlobular artery branched mainly in the dorsal half of the superior pole of the kidney and to a lesser extent in the ventral half.

Table 2

Blood supply variants for the superior polar segment

Variant 1	Variant 2	Variant 3	Variant 4
41.2 % of cases	32.3 % of cases A. ventralis (II) ↓	21.2 % of cases	5.3 % of cases
A. ventralis (II) ↓ 1 A. interlobares – 1 (III) ↓ **superior polar segment**	1 A. interlobares – 1 (III) ↓ **superior polar segment** ↑ 1 A. interlobares – 1 (III) ↑ A. dorsalis (II)	A. renalis (I) ↓ 1 artery ↓ **superior polar segment**	A. dorsalis (II) ↓ 1 A. interlobares – 1 (III) ↓ **superior polar segment**

Blood supply variants for the inferior polar segment

In the studied group of preparations of arterial vessels of the human kidney (29 preparations), where the ventral artery branches according to the dispersal type, and the dorsal one branches according to the magistral type, three variants of blood supply to the superior polar segment were identified (Table 3). In the 1st variant (68.3 % of cases, with $p < 0.05$), the blood supply to the inferior polar segment was carried out through the 1st segmental artery, A. interlobares – 1 (III), branching from A. ventralis (II). In the presented variant, the interlobular artery branched mostly in the ventral and to a lesser extent in the dorsal part of the inferior pole of the kidney. In the 2nd variant (27.4 % of cases, with $p < 0.05$), two segmental arteries, A. interlobares – 1 (III) participated in the blood supply of the inferior polar segment, one of which branched from A. ventralis (II), and the other one from A. dorsalis (II). In the presented type, the interlobular artery branching from A. ventralis (II) supplied the ventral and dorsal halves of the inferior polar segment; and the interlobular artery branching from A. dorsalis (II) supplied blood to the posterior parts of the inferior polar segment. In the 3rd variant (4.3 % of cases, with $p < 0.05$), the blood supply to the inferior polar segment was carried out through the 1st segmental artery, A. interlobares – 1 (III), branching from A. renalis (I).

Table 3

Blood supply variants for the inferior polar segment

Variant 1	Variant 2	Variant 3
68.3 % of cases	27.4 % of cases A. ventralis (II) ↓	4.3 % of cases
A. ventralis (II) ↓ 1 A. interlobares – 1 (III) ↓ **inferior polar segment**	1 A. interlobares – 1 (III) ↓ **inferior polar segment** ↑ 1 A. interlobares – 1 (III) ↑ A. dorsalis (II)	A. renalis (I) ↓ 1 artery ↓ **inferior polar segment**

DISCUSSION

The stage-by-stage topographic and anatomical analysis demonstrated the following most common variant of branching of the links in the arterial bed of the kidney: 1) dichotomous (70 %, 81/116) division of A. renalis (I) to the ventral and dorsal branches (II) (54.3 %, 63/116) at a distance from the hilum of the kidney (70 %, 44/63). In the study by Bouzouita et al. (23), the division of A. renalis (I) into the ventral and dorsal branches (II) was found in 95.7 % of cases (n=68/71); in the study by Daescu et al. (24), in 70 % of cases (n=42/60); in the work by Macchi et al. (19), in 66.6 % of cases (n=10/15). In the study by Daescu et al. (24), the separation of A. renalis (I) at a distance from the hilum of the kidney was observed in 81.67 % of cases; in the hilum of the kidney in 10 % of cases; inside the sinuses in 8.33 % of cases (n=60). 2) The most common type of intra-organ branching of the arteries of the 2nd and 3rd orders was when the ventral artery (II) branched according to the dispersal type, and the dorsal one (II) branched according to the magistral type (46.2 %, 29/63).

The calculation found that with the dispersal type of branching in the arteries of the 2nd order, a greater number of segmental arteries were found than in the magistral (4 ± 1 and 3 ± 1 (X ± m), respectively). In addition, with a loose type of branching, the hierarchy of the renal artery was represented by six links, and the magistral type by five links. For any type of branching, the segmental arteries correspond to the interlobular arteries (III), the number of which equals on average (X±m) 7±1. The presented data are comparable with the study by Macchi et al. (25), indicating 6.3 (range 4-8) segmental arteries, which, according to the authors, are from 7.3 segments (range 5-9).

The analysis found that pools on average (X±m) from 1 to 3 segmental arteries can be distributed in one segment of the kidney, at $p \leq 0.05$. Various studies point to a similar variant of multiple vascularization, in which one segment is supplied with blood by a segmental artery, which is the main contradiction to the generally accepted five-segment concept of the structure of the arterial bed of the kidney (9, 19). In the study by Macchi et al. (19), multiple vascularization was observed in 66.6 % of cases (n=10/15): several arteries fed the upper pole segment in 3/15 cases, the upper anterior – in 5/15 cases, the lower anterior – in 6/15 cases, and lower pole – in 2/15 cases.

In the course of comparing the results of this study with the generally accepted concept of a five-segment structure of the kidney, we found that in the CPHKAS group under study (n=29), the blood supply to the upper anterior, lower anterior, and posterior segments is carried out through the 1st interlobar (III)/segmental artery originating from the ventral artery system (II) on the way to the upper anterior and lower anterior segments and from the dorsal artery (II) on the way to the posterior segment.

The pole segments had different variants of blood supply. Most often, the upper pole segment was supplied with blood by the 1st segmental artery, departing from A. ventralis (II), less often by the 1st segmental artery extending from A. renalis (I) (21.2 %) or A. dorsalis (II) (5.3 %). The inferior pole segment was also predominantly supplied with blood by the 1st segmental artery from A. ventralis (II) (68.3 %), less often using the 1st segmental artery extending from A. renalis (I) (4.3 %). Several sources of blood supply to the pole segments (from the system of the ventral and dorsal arteries) were found in 32.3 % of cases for the upper pole segment and 27.4 % of cases for the lower pole segment.

In the study by Mishra et al. (26), four sources of the superior segmental artery were identified: ventral artery 40 % (20/50), middle segmental artery 28 % (14/50), apical segmental artery 20 % (10/50), and dorsal artery 10 % (5/50); in one case the superior segmental artery was absent. In another study by Rani et al. (n=40), a variant of the structure of the arterial bed of the kidney, similar to the one selected by us, was examined, when A. renalis (I) branched into ventral and dorsal branches (II), were subsequently the ventral branch (II) gave off the apical, superior, middle, and inferior segmental branches, while the dorsal (II) continued as the posterior segmental artery; the type of branching of the arteries of the 2nd order (main or loose) is not specified. The authors point to variations in the origin of the apical segmental artery (60 %, 24/40), it originated from a common trunk together with the superior segmental artery; in 40 % (16/40), it branched off independently from the main renal artery); as well as variations in the origin of the inferior segmental artery (50 %, 20/40), it originated from a common trunk together with the middle segmental artery; in 45 % (18/40), it branched independently from the main renal artery (27).

As a result of the study, it can be concluded that the variational anatomy of the kidney segments is determined primarily by the division of the magistral renal artery (di- or trichotomy), as well as the type of branching of its intraorgan branches (magistral or loose). Each segmental artery has its own origin, localization, and arterial basin.

CONCLUSION

According to our study of the most common variant of branching in the arterial bed of the kidney in the existing cohort (separation of A. renalis (I) into ventral and dorsal branches (II), where the ventral artery has a scattering type of branching, and the dorsal (II) – magistral) and when comparing the obtained results with the works of various authors, it can be concluded that a revision of the generally accepted five-segment concept of the structure of the arterial bed of the kidney is necessary due to the presence of variants with multiple vascularizations of one segment, as well as variations in the structure and sources of segmental arteries.

Due to the prevalence of the use of imaging diagnostic methods and the extensive use of partial nephrectomies, the ideas about variations in the structure of the arterial bed of the kidney are known. However, a consensus revision and modification of the generally accepted five-segment concept of the structure of the arterial bed of the kidney with the approval of the general anatomical nomenclature of atypical variants of the angioarchitectonics of the kidney are still relevant.

ACKNOWLEDGMENTS

The article was published as part of the implementation of the Russian Foundation of Fundamental Research (RFBR) grant under agreement No. 20-315-90008/20.

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