UNIVERSITY “OVIDIUS” CONSTANTA
FACULTY OF MEDICINE
DEPARTMENT OF NORMAL AND PATHOLOGICAL MORPHOLOGY

ARTERIO-VENOUS VASCULARISATION OF THE KIDNEY AND ITS SURGICAL IMPORTANCE

-ABSTRACT OF PhD THESIS-

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Constanta
2013

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INTRODUCTION

As a vital organ function, kidney interferes with the hypothalamus, pituitary gland, adrenal and skin to adjust discharges of water and some substances catabolic solvent, not only as effector organ but also the place for secreting local factors, equipped with effects modeling processes taking place in its various departments.

The importance of the kidney in the body resulting from the fact that it is the most richly vascularized organ, renal arteries are the largest branches of the aorta and veins of the largest branches of the inferior vena cava, in relation to the volume of blood that enters into the organ

Achieving renal transplantation has not fully solved the surgical problem as thought. The difficulties encountered, in particular reduced opportunities to find a donor makes to continue to give importance to the segmentation surgery, kidney and finding new operative techniques, renal transplantation is a therapeutic that appeals only irreversible renal failure.

V. Delmas said that "in order to clarify the best possible kidney segmentation problem by examining variations which may occur in connection with this, it is best first to study vascular changes, particularly arterial and venous and then the urination, linking these elements into a coherent whole. "

As in other parts of the body , the needs of modern surgery for the kidneys are those that determine the anatomical and direct research. Indeed, the systemic study of renal vessels knows unmatched momentum with partial nephrectomy and sequence work, although they fail to clarify some knowledge on this topic and leaves room for discussion and further clarification and details.

Many studies in ways that ranged from age to age, renal vessels were the subject of many research authors, proof being the rich bibliographic material there. From the dissection and injection-corrosion was reached modern methods of study: ultrasound, angiography, and magnetic resonance imaging scanner (MRI). Of these the most used is angiography , showing that path of renal vessels and their branches and origin,the mode and distribution of collateral and terminal branches are numerous and important

But on this Larget said: "The impression that you have in front a cliche of renal arteriography is an infinite variety and the first move is discouraging, because there is no distribution that is comparable to the multiple ending modes of renal artery ".Indeed, sometimes because of the wealth of the distribution of renal artery , it is difficult to interpret renal angiography. But a perfect technique renal angiography helps to see details measuring 0.2 mm and observe arcuate arteries, smooth collateral circulation, to see even renal glomeruli. Thanks to the fine images is presented a new semiology impairment. The indication of renal angiography is in steady progression in recent years in urology and vascular surgery: partial adjusted nephrectomy ,intrasinusal approach of the pelvis, vascular treatment of hydronephrosis, the stenosis, the renal arterial aneurysms, trauma of renal (kidney being the most commonly interested in abdominal trauma), it does not provide a real help unless it is possible to correctly interpret the available distribution of arteries. Information obtained may be faced with those provided by the anatomy of renal microangiografia and surgical parts.Worldwide papers appeared in this period are extremely numerous and therefore bibliography that I had the opportunity to consult is very rich. The conclusion drawn from the analysis of bibliographic material is that there are many things still unspecified or unknown, from embryological development of renal vessels

and vascular segments ending with the existence of autonomous renal parenchyma in relation to how the branching of the renal arteries, which generates statistical differences (sometimes significant) and contradictions on some aspects of the morphology of renal vessels. These controversial issues are because of the multitude of options that the renal vessels is due to several factors, especially the different number of cases on which to work ,and working methods.First giving equal importance of the pyelo- caliceal system, veins and arteries to describe kidney segmentation in recent decades most authors are unanimous in recognizing the vital importance of renal segmentation. Despite differences of conception, most anatomical studies and especially radioanatomical concludes to be founded on arterial segmentation module division, or the origin of the segmental arterial branches.I had the opportunity of regular communication of the results of various conferences both nationally and internationally, abstracts published in edited volumes on this occasion (Bruxelles, Rouen, Clermont Ferrand, Consstanța, Graz) or rated journals ("Morphologie "the publisher Elsevier) and I also published" in extenso "in Romanian Journal of Functional and Clinical Anatomy, macro- and microscopic and anthropology.My work has only macroscopic appearance of renal vessels and their importance in kidney segmentation and thus in achieving partial nephrectomy and renal transplantation.At the general chapter on the history of renal vascular study, we review the contributions of various authors to describe the renal vasculature, from ancient times until today.Renal artery anatomy is then tackled the man, insisting on the origin, path, size, termination reports and how these vessels and their branches, as shown in his famous treaties Grégoire Poirier, Papin, test, Rouvière, Paturet, Gray, Chevrel, Kamina, and in articles in magazines, old and recent.In a separate chapter is treated in detail, given the importance of this topic, many

variants of renal arteries; variants of origin, length, size, trajectory, end, distribution and number.Another chapter covers the more general problem of segmentation discussed kidney, which demonstrated the Hyrtl period 1863-1873, still sparks controversy today.Studies on the renal vein are much lower number than the renal artery, which is why smaller scope of this chapter.The personal side of the paper first deals with the methods and material work, indicating that the study was conducted on a relatively large number of cases (742 for arteries and only 176 for veins), using both traditional methods of operation: dissection, injection of contrast medium (barium sulfate) followed by radiography injection molded parts and plastic injection followed by corrosion, we resorted to modern methods represented by color Doppler ultrasound, angiography (CT angio simple, using dimensional reconstructions) and IRM methods give very precise information, particularly on the origin, path and morfometrical aspects of renal vessels.The next chapter presents the results obtained in relation to each statement mentioned in the general reference, on the morphology of the renal artery and renal vein within each chapter being made discussions on personal results, comparing them with those in the literature, the illustrated by graphs and tables conclusive and supported by a rich personal iconography that leaves no room for interpretation that could arise questions about the claims.In the conclusions chapter are presented some clarifications on issues that have particular importance in surgery, while seeking to explain differences between results due to personal and literature. It also shows the importance of medico-surgical study performed, which confirms that this study is useful not only morphological but also for the surgeon, particularly urology, which often can be put into difficulty when a variant is found in the renal vascularization .The very extensive bibliography is at the end of each chapter, selective bibliography was recorded and played back to the end of the

general literature.In pursuing my PhD thesis I mention that I benefited from my colleagues in the subject of Anatomy, Faculty of Medicine, Constanta, anatomy lab with extensive experience in the study of the cardiovascular system, especially the renal vasculature, plastic injection followed by the numerous corrosion and high quality.I bring warmth thanks to Mr. Professor Petru Bordei, scientific leader of the thesis, one of the best connoisseurs of renal vasculature without any doubt with unanimous national and international recognition.

SPECIAL SECTION

METHODS AND MATERIALS OF WORK OBJECTIVES TRIALS

My study of renal arterial vascularization was performed on a total of 742 human kidney or gutted (fresh and kept in formaldehyde) or in situ, in the halls of dissecting cadavers in the anatomy lab or the halls of forensic necropsy. Dissection were made on 248 kidney Plastic injection on 116 cases , and contrast injection in 58 kidneys. This statistic is added 204 aortic angiography, 98 angioCT, 16 MRI scans , Dopller 20 and a number of 176 cases that were followed only the morphological characteristics of the renal veins. Veins we studied by dissection (52 cases) plastic injection (102 cases) and injection of contrast agent (22 cases). Not all anatomical landmarks could be studied in the studied cases , each anatomical landmark being watched on a number of different cases.I followed and the place of origin of the renal arteries in relation to the backbone and the other side of the abdominal aorta adjacent to renal arteries, especially the celiac trunk, superior and inferior mesenteric arteries and in relation to terminal bifurcation of the aorta. Terminal branches of the renal arteries we watched only to interlobular arteries that we have studied in relation to the portion of the renal parenchyma they serve, which is very important for determining kidney segmentation. We performed measurements of the length and size of renal arteries and their collateral branches and terminal size is appreciated especially on angioCT and ultrasound, as the preparations or injected formaldehyde kydneys suffers variations due to the action of formalin shrinkage or variations due to varying pressures under which injections were made.Say that the kidneys studied were collected from deceased by medical or surgical diseases not directly concerned kidney.

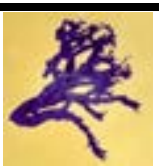
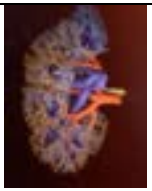
Table. I - METHODS USED

NR.	METHOD	NR. Of KIDNEYS	PHOTO
1.	Dissection	248	
2.	Plastic injection	116	
3.	Contrast material injection	58	
4.	Angiography	204	

5.	Angio CT	98	
6.	MRI	18	
	Total	**742**	

Angiography that I had the opportunity to review existing in the collection , came from the anatomy lab of the Faculty of Medicine, and from Centre for Imagistic Exploration Medimar of the Emergency Hospital in Constanta, were executed on a computer GE LightSpeed 16 Slice CT Scanner. We also had available and executed angiography in Diagnostic Center Pozimed, being executed on a computer VCT64 Slice CT Scanner GE LightSpeed. Angiography provides information on the origin of the arteries particularly in relation to the spine, the size, their path and direction, but also on their collateral branches and terminal.Scans were performed in the Euromedic Center on a GE Vivid 3 device, produced by General Electric Medical System. Color Doppler ultrasound were performed on young subjects, healthy volunteers (students from the Faculty of Medicine) in Euromaterna Hospital in Constanta, on a GE Voluson E8 machine being executed in two planes: sagittal (longitudinal) and transversal. The ultrasound can assess the following parameters morphofiziological of vascular branches with their origin, path and direction, size and length of torso vascular lumen and blood velocity in systole and diastole.

Table. III - Injection plastic mass in to the Vein

NR.	V. KID	V+ PIELON	A+V+ PIELON	A+ Vein	NR. KIDNEY	CORROSION
1	+	-	-		18	
2			-	+	17	
3			+		52	
4.		+			15	
TOTAL					102	

RESULTS AND DISCUSSION OF THE RENAL ARTERY MORPHOLOGY

ORIGIN OF RENAL ARTERY

The detachement place of renal artery from the aorta(the level of the aorta face from witch the artery originates) i watched a number of 417 cases, of which 212 cases wereon the right and 205 cases on the

- left side of of the aorta: 238 cases (57.07% of cases), right renal arteries 101 (47.64%) and 137 left renal arteries (66.83%)
- of the posterior side of the aorta: 120 arteries (28.78% of cases), 82 right renal artery (38.68%) and 38 of the left renal artery (18.54%);
- the anterolateral aspect of the aorta: 42 renal arteries (10,07 of cases), 22 right renal artery (10.38%) and 20 of the left renal artery (9.75%);
- the front of the aorta 17 cases (4.08% of cases), 7 right renal artery (3.30% of cases) and 10 of the left renal artery (4.88%).

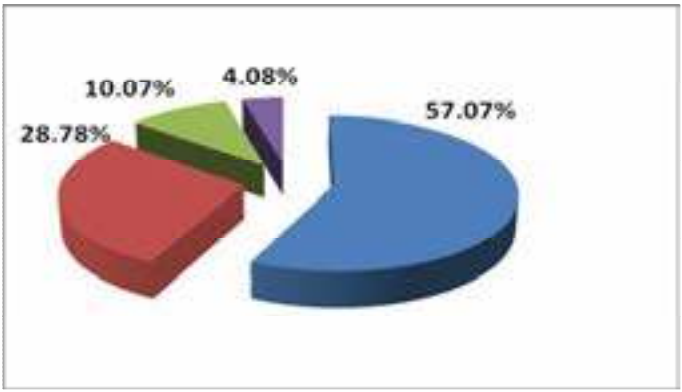


Figure no. 1 – Aortic origin of the renal artery

-57%-lateral side
-28,78%-postero-lateral side
-10,07%-antero-lateral side
-4,08%-anterior side

Fig. 36 - Right renal artery origin on the posterior side of the aorta, left renal artery with its origin on the side of the aorta. Both roads are straight oblique downward trajectory. Left renal artery is larger, originating slightly below the straight.

Fig. 37 - The left renal artery origin on the anterolateral of the aorta and bifurcated in the ending near the kidney.

Table. IV -The origin of the renal arteries on the face of aorta.

AUTHOR	LATERAL FACE OF AO.	ANTERO-LATERAL FACE OF AO.	POST-LATERAL FACE OF AO.	ANTERIOR FACE OF AO.
Talpeş	116 (62,37%) R61 (62,24%) L.55 (62,5%)	29 (15,59%) R.20 (20,41%) L9 (10,23%)	37 (19,89%) R15 (15,31%) L.22 (25%)	4 (2,15%) R.2 (2,04%) L.2 (2,27%)
Novac	42 (53,85%)	22 (28,20%)	14 (19,90%)	
Personal Cases	**238 (57,07)** **R.101 (47,64%)**	**42 (10,07%)** **R.22 (10,38%)**	**120 (28,78%)** **R.82 (38,68%)**	**17 (4,08%)** **R.7 (3,30%)**

	L.137 (66,83%)	**L.20 (9,75%)**	**L.38 (18,54%)**	**L.10 (4,88%)**

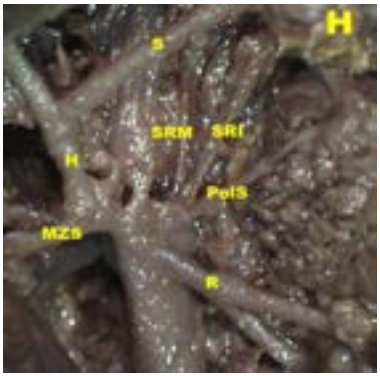


Fig. 38 - The origin of the left renal artery on the front of the aorta, the inferior oblique trajectory and finished close the bifurcation of the aorta.

Fig. 39 - Right renal artery originated above-located on the anterolateral aspect of the aortic bifurcation and ends close to the kidney, and the left renal artery originates on the posterior side of the bifurcation of the aorta and ends into the hilum of the kidney.

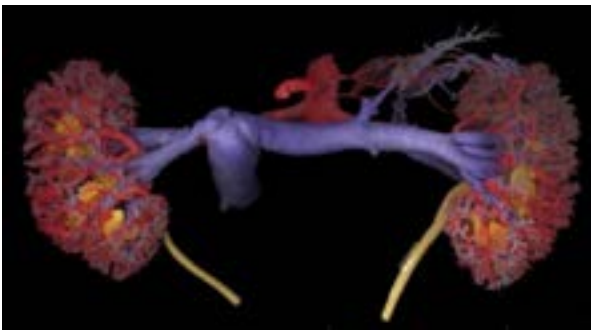


Fig. 40 - Right renal artery originates on the posterior side of the aorta and higher than the origin of the left renal artery, which has its origin on the side of the aorta.

Fig. 41 - Renal arteries originate from the same side of the aorta at the same level.

Fig. 42 - Right renal artery origin, in females (on the anterolateral side of Ao.), is located above 5.4 mm than the origin of the left renal artery (on the lateral side of the aorta).

Table. V - THE COMPARATIVE ORIGIN OF THE RIGHT AND LEFT RENAL ARTERY.

AUTHOR	THE ORIGIN
GRAY	The same level
GRÉGOIRE	The same level
HELIN	Right above a few millimeters
HELM	Left sometimes above
PATURET	Left above (mg.inf.L1)
POIRIER	Left above (1/2 sup. L1)
ROUVIERE	The same level
TESTUT	The same level

ZONDECK	Left sometimes above

Fig. 44 - Left renal artery (in males) originating from the aorta lying above than the right renal artery origin.

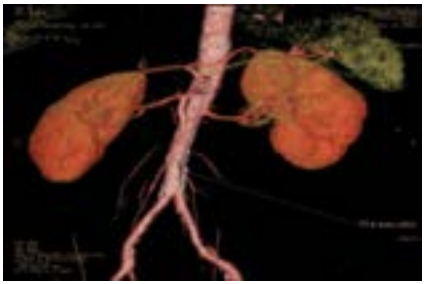


Fig. 45 - Right renal artery origin (on the posterior side of the aorta), located above the renal artery originated from the left (on the side of the aorta) in males.

Table. VI - THE ORIGIN OF BOTH RENAL ARTERIES , COMPARED RIGHT-LEFT

AUTHOR	TOTAL CASES	RIGHTABOVE	The same level	ABOVE LEFT
Ternon (1959)	80	20,1%	34,4%	45,5%
Calas (1963)	83	65%	frequently	Rare
Ecoiffier (1972)	1000	20,5%	71,8%	7,6%
Delmas (1983)	49	17(34,69%)	18 (36,73%)	14(28,57%)
Bordei (1992)	119	85 (71,43%)	21 (17,65%)	13 (10,92%)
Novac (2009)	148	81 (54,73%)	29 (19,59%)	38 (25,48%)
Talpeş (2011)	119	78 (65,54%)	19 (15,97%)	22 (18,49%)
Azis Olgun (2012)	168	91 (54,16%)	28 (16,67%)	49 (29,17%)

Personal Cases (2013)	**237**	**155 (65,40%)**	**27 (11,39%)**	**55 (23,21%)**

Fig. 46 Renal arteries in women: right renal artery originated above (at the upper edge of the vertebra L1) than the left (in the upper third of L1 vertebra).

Fig. 47 - Right renal artery in males: originates on the front of the aorta (the third lower vertebra L1),lying higher than the left renal artery, which has its origin on the side of the aorta (the disc L1-L2 intervertebral

I watched the origin of the renal arteries in relation to the backbone on 244 cases, of which 124 right renal artery and left renal arteries 120. The origin of the renal arteries in the aorta is highly variable, finding it between intervertebral disc T12-L1 L1 and L2 vertebra to the lower edge.

The most common renal arteries had their origins in the third lower L1 vertebra in 52 cases (21.31% of cases), 18 cases were right renal artery (14.52% of cases) and 34 cases arteries left kidney (28,33% of cases).

In order of frequency we found the following origins:

- L1-L2 intervertebral disc 46 renal arteries (18.85% of cases), 16 right renal artery (12.90%) and 30 of the left renal artery (25%);
- Third middle L1 vertebra 44 renal arteries (18.03% of cases), 32 right renal artery (25.81%) and 12 of the left renal artery (10%);

- Third upper vertebra L1: 24 arteries (9.84% of cases), 12 right renal artery (9.68% of) and 12 of the left renal artery (10%);
- Third upper vertebra L2: 20 arteries (8.20% of cases), 14 right renal artery (11.29%) and 6 of the left renal artery (5%);
- Third lower vertebra L2 artery 18 (7.38% of cases), 12 right renal artery (9.68%) and the left renal artery 6 (5%);

Fig. 48 - Right renal artery originating from the third lower vertebra L1.

Fig. 50 - Right renal artery originating from the L1-L2 intervertebral disc and the left, with the origin located below (in the third upper vertebra L2) has a curved trajectory, like the letter omega.

Fig. 51 - Right renal artery originating from the aorta to the third medium of L1 vertebra and slightly obliquely upward trajectory like an italic"S" inverted, left renal artery obliquely downward trajectory with omega-shaped

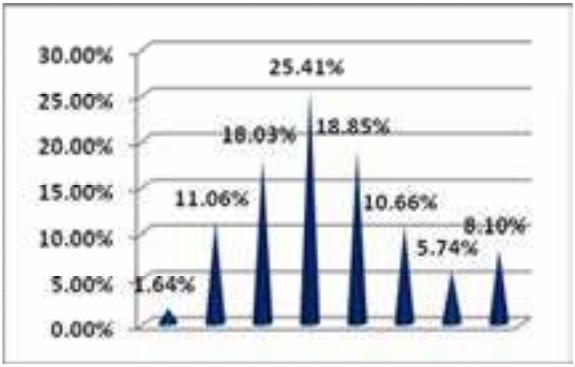
Fig. 52 Males left renal artery originating from the upper edge of the vertebra L2 and oblique straight downward trajectory, right renal artery, originating from the third lower vertebra L1 has curled

downward trajectory.

- Third middle vertebra L2: 14 renal arteries (11.29% of cases), 6 right renal artery (4.84%) and 8 of the left renal artery (6.67%);
- the lower edge of the vertebra L1: 10, renal arteries (4.10% of cases), 6 artery (4.84%) and 4 of the left renal artery (3.33%);the upper edge of the vertebra L1: 6 renal artery (2.46% of cases) L2, four right renal artery (3.23%) and 2 left renal artery (1.67%);

Fig. 53 Males left renal artery originating from the upper edge of the L2 vertebra and slightly obliquely upward trajectory, right renal artery originated from the third lower vertebra L1

- T12-L1 intervertebral disc: 4 renal artery (1.64% of cases), 2 right renal artery (1.61%) and 2 of the left renal artery (1.67%);
- the upper edge of the vertebra L2 three renal arteries, one case on the right (0.81%) and 2 left renal artery (1.67%);
- the bottom of the L2 vertebra: three renal arteries (1.23% of cases), 1 case Right (0.81%) and 2 of the left renal artery (1.67%).



1,64%-intervertebra T12-L1
11,06%-1/3sup L1
18,03%-1/3 median L1
25,41%-1/3 inf L1
18,85%-intervertebra L1-L2
10,66%-1/3 sup L2
5,74%-1/3 median L2
8,10%-1/3 inf L2

Figure no. 13 - THE ORIGIN OF THR RENAL ARTERY RELATED TO THE SPINE

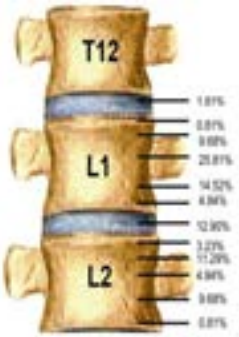


Fig. 55 - The origin of the renal arteries in relation to the spine.

Table. IX - THE ORIGIN OF THE RENAL ARTERY RELATED TO THE SPINE IN PERCENTAGE%

LEVEL	Adachi (1928)	Anson-Vay (1936)	Soutoul (1961)			Guntz (1967)	Koumare (1973)	V.Delmas (1983)			Bordei (1992)			Novac (2009)	Talpeş (2011)			PERSONAL CASES(2013)		
			Total	R	L			Total	R	L	Total	R	L		Total	R	L	Total	R	L
							0,16													
T12																				

	1,82		6,5	6,06	6,93	**9**	0,32	1		1													
	2,73						2,7	2	1	1	0,99	0,88	1,12	2,35				**1,64**	**1,61**	**1,67**			

	4,54		2,5	2,02	2,97		8,25	14	8	6	8,22	9,41	6,72	12,94	8,28	12,5	3,70	**11,06**	**10,48**	**11,67**
L1	10,91	3				13	18,25	18	11	7	22,86	24,71	20,52	20	11,83	18,18	4,94	**18,03**	**25,81**	**10**
	20,91	5	14,5	12,12	16,83	19	22,38	25	7	18	26,48	29,12	23,13	24,71	47,93	42,04	54,32	**25,41**	**19,30**	**31,67**
	31,82	18	23	23,23	22,77	23	28,25	23	14	9	20,23	16,47	25	17,65	14,79	12,5	17,28	**18,85**	**12,90**	**25**

	14,54	26	22,5	21,21	23,76	15	8,73	10	5	5	14,47	11,76	17,91	12,94	9,47	6,82	12,35	**10,66**	**14,52**	**6,67**
L2	6,36	19	12	11,11	12,87		7,94	11	4	7	3,78	4,12	3,36	3,53	3,55	3,41	3,70	**5,74**	**4,84**	**6,67**
	2,73	10	7,5	8,08	6,93	**16**	2,06	1		1	2,24	1,76	-	3,53	3,55	3,41	3,70	**8,61**	**10,48**	**6,67**
	3,64	13	1	2,02			0,79	2	1	1										
		2	2	2,02			0,16													
L3			3,5	4,04	2,97						2,24	1,76	-	2,35	0,59	1,14				
		1						1	1											

		1						2	1	1										

		1				**5**														
L 4		1																		
			2		3,96			1		1										
			2	4,04																
	110	100	200	99	101	700	630	111	53	58	608	340	268	85	169	88	81	**224**	**124**	**120**

RENAL ARTERY MORPHOMETRY

Table. XIII – THE SIZE OF THE RENAL ARTERIES

AUTHOR	DIMENSION
Papin	8 mm
Luschka	8 mm
Ternon	4-6, 5 mm
Schmerber	6-7 mm in man
	5-6 mm in woman
Testut	5-7 mm
Paturet	7 mm
Merklin & Michels	6-8 mm
V. Delmas	man – right:7,7 – 10,8 mm; left: 8,7 - 12 mm
	woman - right:5,8 – 8,5 mm; left: 5,7 – 8,6 mm
Kamina	7 mm
Chevrel	4-6,5 mm
Bordei	right: 7-10 mm; left: 6 – 9 mm.
Talpeş	right: 4,4-6,8mm; left: 4,3-7,2 mm.
Personal Cases	***right: 4,2-7,2mm; left: 4,1-7,3 mm.***

Fig. 87 - Right renal artery caliber (4, 5 mm) greater than the size of the left renal artery (4, 4 mm).

Fig. 88 - Right renal artery caliber 4, 5 mm left renal artery with 4, 4 mm.

Fig. 91 – The caliber of renal arteries (4, 6, and 4 mm right renal artery, left renal artery 3 mm)compared with celiac trunk size (5, 7 mm), superior mesenteric artery (5, 1 mm) and inferior mesenteric artery (2, 7 mm) ..

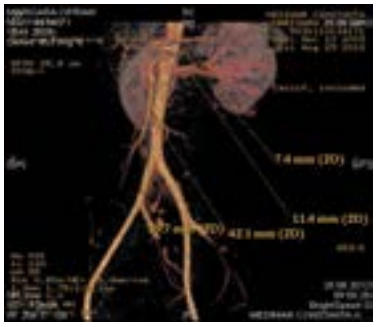


Fig. 93 - Abdominal aorta at the origin of the renal artery has a diameter of 11.4 mm.

Compared with other big size arteries of the abdominal aorta, the renal artery caliber is always biger with 1,2-3-4 mm than the inferior mesenteric artery,lower then the celiac trunk caliber with 1.4 to 4 mm and 1 5-3,5 mm in relation to the superior mesenteric artery.In relation to the caliber of the aorta at the origin of renal arteries , which we found between 9.4 to 12.4 mm , the renal arteries caliber is 1/4-2/3 of the abdominal aorta at the kidneys level.

Renal artery trunk length

Table. XV - Renal artery trunk length

AUTHOR	RIGHT	LEFT
Poirier	5-6 cm	
Papin	+ 1 cm	
Gregoire	3 – 3,5 cm	
Testut	3 – 5 cm	
Ternon	5 – 6 cm	
Paturet	+ 1 – 2 cm	
Merklin & Michels	0,5 – 8 cm	
V. Delmas	man: 3,2 – 8 cm	man: 0,6 – 5,5 cm
	woman: 2-7 cm	woman: 2 – 5,5 cm
Kamina	6-7 cm	5 cm
Chevrel	5-6 cm	3-4 cm
Bordei	5-7 cm	3-4 cm

Talpeş	1,8 – 8 cm	0,5 – 6 cm
Personal cases	***3,4-7,4 cm***	***1,2-5,8 cm***

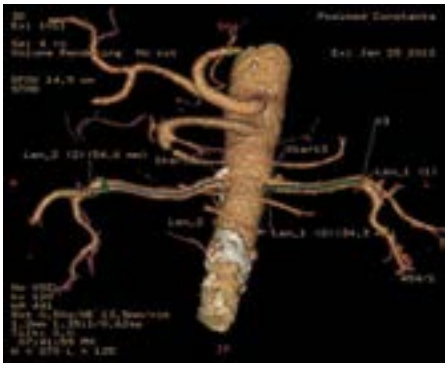


Fig. 94 - Right renal artery with a length of 5, 46 mm ,left renal artery with 34, 3 mm.

THE ENDING PLACE OF RENAL ARTERIES

We studied the renal artery ending in a total of 164 cases, including 87 on the right and 77 on the left.

- ending closer to renal hilum i found it on the right side in 23 cases (26.44%), while on the left we found 15 cases (19.48%);
- ending near the hilum closer to the aorta we founded on the right in 12 cases (13, 79%) and on the left in 19 cases (24.68%);
- near hilum end halfway between the aorta and kidney, I met her on the right side in 18 cases (20.69%) on the left side in 15 cases (19, 48%);
- near hilum end I met on the right in 19 cases (21.84%) and in 12 cases (15.58%) for the left renal artery;
- intrarenal hilum end I met in 15 cases on the right side (17.24%) and left în16 cases (20.78%).

Fig. 106 - Crotch extra renal hilum closer to the aorta, into an upper and lower ram. Renal hilum into the slit

Fig. 107 - Left renal artery originated from the aorta lying above than the origin of right renal artery . Left renal artery branches off extrahilum closer to the kidney, into an anterior and posterior branche. Right renal artery is trifurcated near enal hilum.

TERMINAL BRANCHES OF RENAL ARTERY

TERMINAL ANTERIOR BRANCHE OF RENAL ARTERY

Of the 288 cases that we have followed for the origin of the anterior artery, of which 157 on the right and 131 renal artery on the left, we found that in 265 cases the anterior branche came from a single renal artery,and in 23 cases from double or triple renal artery

. Depending on how the renal artery origin ends , I found the following situation:

- in 62.85% of cases anterior branche came through the bifurcation of the renal artery ;
- in 32.98% of cases anterior branche came trought trifurcation of the renal artery;
- in 4.17% of cases) had its origin in a renal artery finished with four branches.

Table. XIX - NUMBER AND APPEARANCE OF ANTERIOR BRANCHES

AUTHOR	SINGLE	DOUBLE	TRIPLE
Arvis	+	-	-
Augier	-	+	-
Callas	+	-	-
Cordier	+	-	-
Ecoiffier	+	-	-
Ferreira	85, 20%	9, 48%	4, 96%
Gerard-Gosset-Graves-Gray	+	-	-
Gregoire-Guntz	+	-	-
Papin-Paturet-Poirier	+	-	-
Rouviere	+	-	-
Schmerber	+ + +	+	-
Testut-Ternon-Torlois	+	-	-
Zondeck	+	-	-
Wiart	+	-	-
Personal cases	**50, 35%**	**42, 36%**	**7, 29%**

Fig. 121 - Right anterior branche from a renal artery bifurcated prehilum closer to the kidneys, into anterior bifurcates branch and posterior branch.

POSTERIOR TERMINAL BRANCH OF RENAL ARTERY

The origin of posterior renal branch i have studied on a total of 288 cases, of which 157 (54.51% of cases) on the right and 131 (45.87% of cases) on the left.

- in 36.46% of cases the posterior branch originated from a renal artery bifurcated ;
- in 27.08% of cases from renal artery trifurcated;

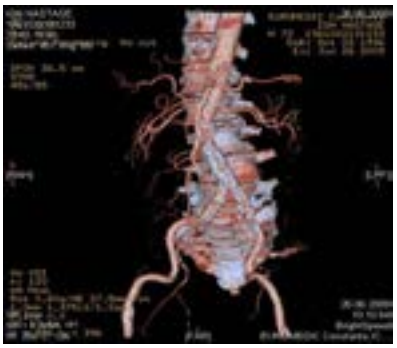


Fig. 124 – Both posterior branches (right and left) start from the bifurcation of renal artery near the hilum closer to the aorta, into an anterior and posterior branches.

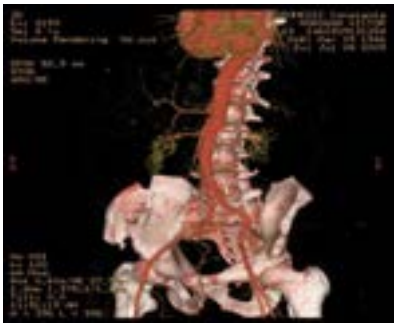


Fig. 125 – Posterior right branch wit origin in a renal artery terminated by trifurcation

- In 4.17% the posterior branch originated in a renal artery finished with four branches,.
- From the aorta we found 7 cases;
- in 29.86% of the posterior branch originated from the anterior renal artery.

Fig. 127 – Posterior branch originating from the ant-sup branch

Fig. 128 – Posterior branch arch

While classics describe in the great majority of cases the appearance of the arch, I foundit in only 134 cases (46.53% of cases).

Table. XXI - THE TERRITORY OF VASCULARISATION OF POSTEROR BRANCH

AUTHOR	Dorsal Valve	Less Inf.Pole	Less Sup Pole	Without Poles
Callas	+ +	-	+	-
Cordier	+ +	-	- +	-
Ecoiffier	+ +	+	-	-
Guntz	18%	57%	16%	9%
Personal cases	**88 (30, 56%)**	**107 (37, 15%)**	**38 (13, 19%)**	**55 (19, 10%)**

ARTERIES OF THE UPPER SEGMENTS

We studied the upper segment of the kidney arteries in 461 cases.Most commonly, the anterior upper segment arteries had their origins in the anterior branch of the renal artery, in 190 cases (41.21% of cases). In most cases it was collateral branch of this artery, 177 cases (38.39% of cases) and in 13 cases (2.82% of cases) anterior upper segment representing an artery originated by terminal branch from the anterior renal artery.

Arteries of the posterior upper segment of the kidney originate most often in the posterior branch of the terminal renal artery, under 1-3 arterial branches that even when single vascularize the back of the upper pole with a less caliber than anterior-superior arteries. Only in 8 cases (1.73% of cases) we found posterior upper segment artery heavier than the previous one.

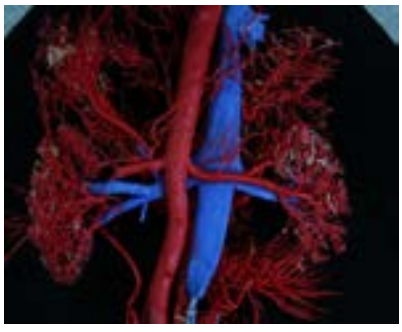


Fig. 136 Anterior artery of the left segment originating from the renal artery and the posterior from the posterior terminal branch forming an arch of renal artery (posterior view).

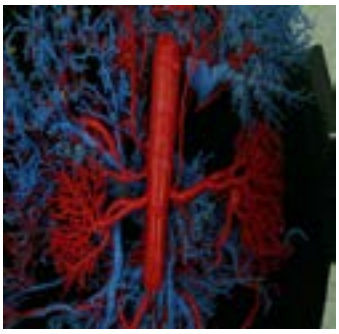


Fig. 140 - Previous artery of the upper segment as the terminal branch of the anterior branch and terminal renal artery of the posterior branch originating in terminal renal artery posterior arch (posterior view).

ARTERIES OF THE LOWER SEGMENT

We studied the artery for the inferior segment (lower polar actual or basal) on a number of 268 cases.Lower segment artery originated from the renal artery in 90 cases (33.58% of total cases).

Fig. 143 Artery originating from the lower segment of the renal artery trunk disconnecting a bulky rear branch

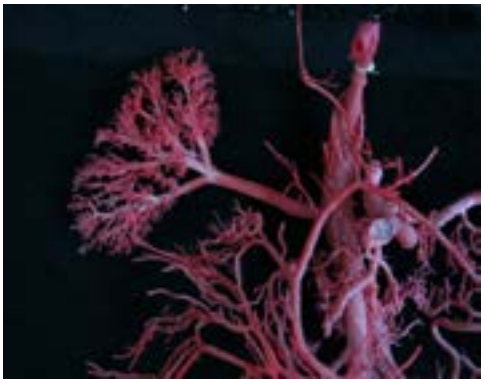


Fig. 146 - Artery originating from the right inferior segment trought the trifurcation of the terminal renal artery.

Of all the cases originating from the renal artery in 35 cases (13.06% of all cases) came from terminal renal artery branch.

In 55 cases (20.52% of total cases), originated in the trunk of the renal artery prior to its terminal branch.

In 12 cases, the lower polar originated in a renal artery that ends with four branches (4.48% of total cases).

Directly from the aorta originated in 13 cases (4, 85% of cases).

In 11 cases (4.10% of all cases) lower segment artery originated from the posterior artery of the kidney.

Of all arteries for lower pole, 171 arteries (63.81% of all lower end arteries) were actual arteries themselves of lower segment and 97 arteries (36.19% of all lower end arteries) were basal arteries.

Fig. 147 Lower segment artery renal artery originating from the trunk above its terminal branch.

LOWER ADRENAL ARTERY

Of the 120 cases followed, in 91 cases (75.83%) we found one lower adrenal artery, and in 29 cases (24.17%) have met two or three inferior adrenal arteries.

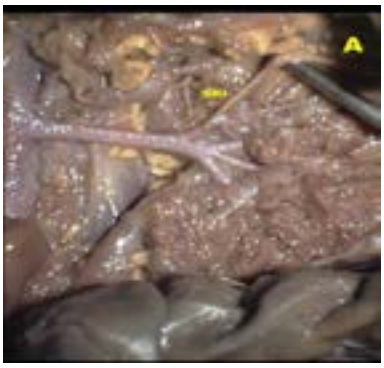


Fig. 152 - Lower left adrenal artery with origin in kidney artery trunk near its terminal branch

Fig. 153 - Right inferior adrenal artery is the terminal branch of the renal artery trifurcation.

The origin of the renal artery at different levels:

- the renal artery trunk: 75 cases (62.5%) in 19 cases (15.83%) giving rise to the upper segment of renal branch ;
- the upper terminal renal artery branch: cases (4.17%) terminal branches of the renal artery in 12 cases (10%);
- in the abdominal aorta 11 patients (9.17%);
- the celiac trunk: 5 cases (4.17%);

Fig. 154 - Right inferior adrenal artery originating from the superior anterior branch, the common trunk with the upper segment artery.

Fig. 155 - Right inferior adrenal artery originating from the anterior middle renal artery branch

Fig. 156 Lower left adrenal artery originating from the aorta ..

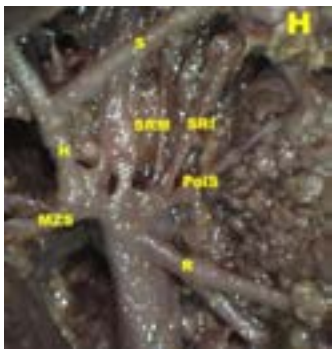


Fig. 158 - inferior adrenal artery originating from the celiac trunk.

Of the 29 cases with multiple inferior adrenal arteries, two arteries have met in 21 patients (17.5%), 3 arteries meeting them in 8 cases (6.67%).

Fig. 161 - Three straight inferior adrenal artery: Two renal artery originating from the trunk closer to the aorta, and the third having its origin throughout the renal artery trunk, but closer to the terminal branch of the artery.

MULTIPLE RENAL ARTERIES

The renal artery number variants that we followed in 208 cases, are that in 40 cases (19.23% of cases) were multiple renal arteries, double in 31 cases (14.90% of cases) and triples of these 16 cases was the right kidney and 24 cases for the left kidney. Only three cases have met multiple bilateral renal artery, two are for double renal artery and one case with triple renal arteries in 9 cases (4.33% of cases)

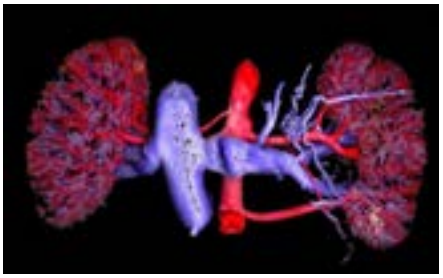


Fig. 162 Case with double left renal artery, the artery is an artery additional for the lower pole.

Fig. 163 - Right renal artery double and triple left.

Fig. 164 - Double renal artery infero-lateral oblique parallel paths. Lower renal artery has retroureteral trajectory

Fig. 166 - Bilateral double renal arteries convergent paths cross

Fig. 169 - Additional renal artery branches off intrasinusal itself.

Fig. 170 - Triple left renal artery: upper pole (less bulky), kidney itself (the most voluminous) and lower pole

Fig. 171 - Case three left renal artery, superior and middle with paths cross, the hilum and lower the lower pole, which is about two inferior adrenal arteries.

Fig. 174 - Three right renal artery, superior and middle arteries terminal having crossed paths. Middle and bottom arteries have a similar trajectory.

GONADAL ARTERIES ORIGINATING FROM THE RENAL ARTERY

I met a number of 16 cases of gonadal artery originated from the renal artery, or additional single (double or triple) or as single artery, either as a second gonadal artery.

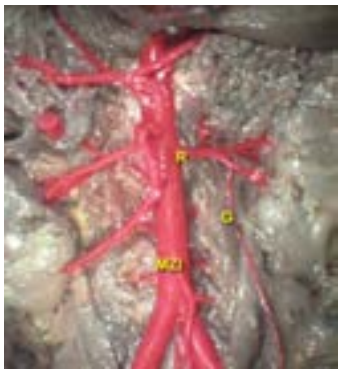


Fig. 175 – Left gonadal artery originating from the lower end of the prior branch of renal artery

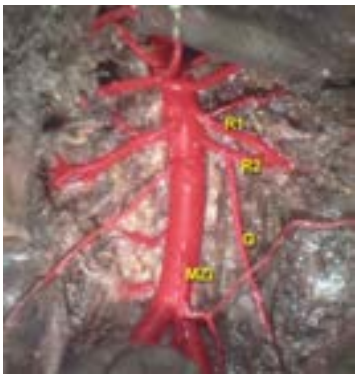


Fig. 176 - Left gonadal artery originating from the lower renal artery.

In the case of gonadal arteries origin of the renal artery, in 12 cases (75%) was a single gonadal artery and in 4 cases (25%) are two gonadal arteries. In all cases encountered in 13 cases (81.25%) gonadal arteries were located on the left and only 3 cases (18.75%) on the right.

Fig. 178 - Upper left gonadal artery originating from the renal artery, with wavy trajectory.

KIDNEY SEGMENTATION

We studied kidney segmentation on a number of 254 kidneys

- 9.45% three arterial segments.
- 4 arterial segments in 39.76%;
- 5 arterial segments (46,46%);
- 6 (4.33%) renal segments

Fig. 185 - Kidney with three renal arterial segments.

Fig. 186 – Kidney with four renal arterial segments

Fig. 187 - Kidney with five renal arterial segments.

Fig. 188 – Kidney with six renal arterial segments

RENAL VEIN

Regarding the formation of the renal vein,this is done:

- From two venous trunks in 56% cases
- of the three venous trunks in 39% of cases;
- four venous trunks in 5%% of cases.

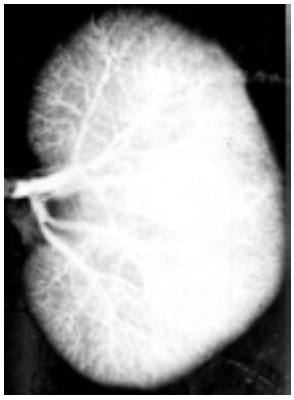


Fig. 193 - Left renal vein consists of two venous trunks: anterior-superior and anterior-inferior, posterior venous branches ending in the past

Fig. 194 - Renal vein is formed by the confluence of three branches: the upper polar, polar medial , and inferior. Medial vein branch ends into the posterior vein.

Fig. 198 - A mold of four renal veins venous trunks: 3 above (upper and lower polar and medial) ending in posterior vena vein trunk.

FORMING PLACE OF RENAL VEIN

We found that the left renal vein may form:

- within the renal sinus (14% of cases),
- near the kidnetynear (18% of cases).
- Ouside the kidney: 68% of cases

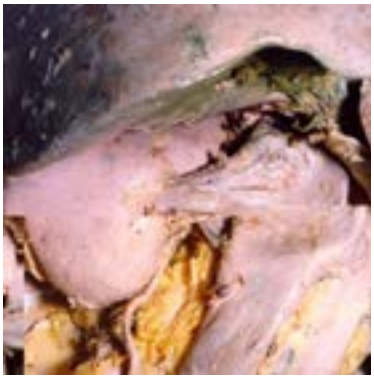


Fig. 203 - Right renal vein is formed intrasinusal. The vein is located anterior of the artery which covers almost all.

Fig. 204 –The renal vein is formed near renal hilum from three collector branches ,the rear once opens in each of the three veins of origin

Fig. 206 - Right renal vein extrahilar formed closer to the kidney, the two logs: the anterior superior vena receiving the upper pole and lower pole, and a receiving branch from the lower third of the kidney.

For the right renal vein we've described the place of forming following this ways:

- Intrasinusal 20% of cases
- juxtarenal: 28% of cases;
- extrarenal: 52% of cases.

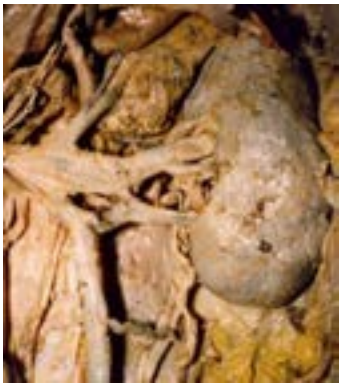


Fig. 209 - Left renal vein consists of two venous trunks left side of the aorta. Strong vertical anastomosis between the two venous trunks. The lower vein trunk less bulky than the

Fig. 211 - The left renal vein trajectory retroaortic

upper ends perpendicular left gonadal vein, which is larger than the lower adrenal vein, renal vein ending in the front of the aorta,medial from the gonadal vein end

The size of the left renal vein I found between 0.8 to 1.8 cm;

Left venous trunk length we found between 7-12,5 cm: the length of the venous trunk as we found between 1, 5-5, 5 cm, at the ending in the inferior caval vein between the right and left vein there is a gap of up to 1-1, 5 cm (20, 21).

We encountered 12 cases the left renal vein was retroaortic trajectory.

Fig. 214 - right renal artery with precav trajectory.

ADDITIONAL RENAL VEINS

In my study, in 14 cases we encountered double renal veins, of which 12 cases (85, 71% of cases) were on the left.

Fig. 223 - Two right renal veins, the inferior less voluminous, forming intrarenal. The superior renal vein is formed extrahilar, at the half of the kidney and inferior vena cava, from the two trunks vein. Inferior renal vein passes anterior ureter.

CONCLUSIONS

From the renal artery vascular variants, I believe that special attention should be paid to the origin and path, level and mode of termination of renal vessels, particularly the arteries, especially their variants: additional renal arteries, renal arteries with retroureteral paths, these being involved in the production of hydronephrosis, inferior adrenal artery variants and gonadal artery origin of the renal artery.

Additional renal arteries originating from the aorta, is one of the most common vascular variants in the kidney is much more common than the existence of additional renal veins, approximately in the ratio of 1/8. Polar arteries originating from the aorta can be damaged during mobilization or other surgical maneuvers on the pole of the kidney and a very important aspect is that higher renal artery segment frequently gives rise to inferior adrenal artery and the inferior segment gives rise to gonadal artery, aspects that must be considered in the conservative renal surgery. During conservative renal surgery interventions outside bleeding and loss of renal parenchyma, arterial injuries were serious consequence segmental ischemia followed by hypertension. The presence of additional renal artery renal transplantation increases complexity because additional kidney showing renal arteries are responsible for a significant failure more important than those with a single renal artery. For these reasons the results of an assessment requirement kidney arterial vascular imaging should precede each kidney sample and each kidney surgery in order to identify any pressure variation.Lower renal segment arteries are involved in the mechanism producing hydronephrosis, often presenting them retroureteral paths, nearby the ureter, which makes a restrictive urine flow. This is important when crossing occurs at levels that the ureter is already narrow : the pelvic-ureteric junction if ectopic kidney or ptosis, or if ectopic artery is low on the iliac ureter.We found that in cases of retroureterale arteries, they originate from the aorta or the renal artery trunk, unhooking close to the aorta, anterior terminal renal artery branch.Retroureteral path of the renal artery is linked to the place of origin of the aorta artery, which is located on the posterior side of the aorta, and sometimes on the side of it. Also, we should not neglect the role of double or triple renal arteries in renal transplantation.The upper segment of renal artery morphology varies widely. Frequently, I met a good separation of the upper renal segment against the mediorenal (over 45% of cases), which allows relatively easy nephrectomy superior performance. It is harder to execute when the high part arteries and anterior-superior segment vascularization or arteries that participate in the vascularization of the upper segment of the posterior segment of the kidney, nephrectomy is more difficult to perform, requiring multiple vascular ligature. In the upper pole nephrectomy which is problematic artery anterior-superior, the rear presenting a less variable morphology, particularly in terms of its origin and the territory of the posterior segment that blood into it. Also of particular importance in an upper pole nephrectomy lower the adrenal artery, especially when it exists as an arterial trunk that arises and gives rise artery segment.

Consider the variability of the percentages from the literature as well as the variance between the individual and the literature on the morphology of the renal artery, and to be due to differences in relation to the geographical area in which research has been carried out, depends on the number of cases that worked, and in fact reported by many authors, differences in the human race. Vascular variability would depend in the same area and some environmental factors that act during organogenesis.Depends a lot of the working methods, angiographic methods giving accurate results on the origin, path and especially

on morphometric renal vessels. This would explain the morphological differences seen in the population of the same geographical area at different time periods.

Gonadal artery origin from renal artery is of particular importance for renal surgery in performing partial or total nephrectomy and renal transplantation, potentially compromising vascular respective gonad, especially when gonadal artery originating from the renal artery is unique and there is a second gonadal artery with the origin of the aorta or other source pressure. Therefore, gonadal artery be preserved with great care to prevent vascular glandular disorder, it represents the main source of pressure gonad. The existence of gonadal arteries originating from the lower renal artery segment is that it can be injured during percutaneous treatment of a pelvis-ureteral junction syndrome, which contraindicate such intervention. Damage to such an artery is followed by a bleeding requiring hemostasis by embolization. Therefore, a technical approach may renal petroperitoneal as an alternative less invasive than conventional surgery in these.

Pelvic renal ectopia is a less common malformation which is diagnosed when there is suffering kidney, incidentally by IVU or post-mortem necropsy. Therapeutic concepts have changed a lot from Marion, who in 1935 said that "any ectopic kidney should be removed." Attitude before an ectopic pelvic kidney is currently facing a similar behavior in the normal kidney, as indicated by the pathology of the surgical act and not to his malpositions.There is a variety of attempts and proposals renal segmentation attempts to take a certain type of blood available in spite of the differences of design, the majority of anatomical studies conclude to a segmentation based pressure or the way of division or the mode of origin of segmental arterial branches.

The study did not aim to define a segmentation model, but tried to. find the basis for a general systematization. Taking as a basis the way the end of the renal arteries and the arteries division mode of the first order, and hence to the number and the distribution of second-order arteries in renal parenchyma (mezopolare, mezoventrale and mezodorsale), we concluded that can not recommend a segmentation model, a systematic scheme to be applied as a rule generation, though most often I met with 5 and 4 cases of renal segments.Because of the variability of arteries taken into account, we found several types of segmentation, each type having its percentage. We thus confirmed the assertion by Delmas, who said that "there is only one type of arterial segmentation and types which may be described to be in a minority, because the kidney is divided into several segments,and so the greater the impression on non segmentation is .

"Applied Anatomy of renal arterial vasculature. Since the distribution of intrarenal arteries is constant and known, the surgeon can now plan the renal parenchyma incision properly. Since the general direction of vessel segmentation in the previous plan , transverse incisions should be made best parallel to them and not perpendicular. The layout of the five segments is fortunately so itself lead to partial nephrectomy, which is the upper or lower pole resection. Attempts to remove the middle or posterior segment are generally impractical and little used. Classification of variants arteries is not only didactic interest, but also surgical

interest. Those who prefer the incision extended from the pelvis up to the upper pelvis to extract stones, you should pay particular attention to the posterior branch of the renal artery. It will find directly in the path scalpel, because passing near the junction between the pelvis and upper calice package, often extending below the rim hilum and thus hidden from view. Effect of the vessel will produce intense bleeding and subsequent ligation witch produce necrosis of the posterior segment.

Mode and site of renal vein directly influence the possibilities for surgical approach to the renal vessels, a long renal pedicle, the renal artery branches intrarenal and renal vein is formed extrarenal facilitating surgical act when it is necessary.

Two particularly aspects in the formation of unique renal veins:frequently non correspondence of the venous branches with arterial branches, and relatively high pressure and renal vein formation unique and juxtarenal intrasinusal, especially on the right, makes it more difficult ,the surgical approach of these branches.

Also, asymmetries are common in the way and formation of renal veins: renal vein with either the place of formation eighter the mode and place and how different from the contralateral renal vein is .Branches of origin for single renal vein are usually of different sizes and rarely have the same caliber as mezorenale branches that are larger than polar venous branches.

Additional renal veins do not always accompany renal arteries further on the contrary, are more frequent cases with no additional renal veins and renal arteries further.

Interestingly, the ratio of the lower pole vein and ureter, the vein passing above the ureter rules . In cases where the posterior lower pole vein passes ureter in posterior, it is high and plied, thus being obstructive for the urine flow and thus constituting one of the cases producing hydronephrosis.

Additional renal veins outside the coexistence of additional renal arteries may accompany variants of renal structure: persistence of fetal lobulation, double ureter,double renal hilum , gonadal artery originated from the left renal artery.

Applied anatomy of renal venous vasculature. During surgery, anterior segmental artery ligation segment resection (partial resection as inferior pole) will control or reduce bleeding pressure tranche section. Significant bleeding can occur in the venous system, however, especially around the pelvis, this being due to the existence of close relationships between the intrarenal veins and the calyx system, but also because systemic venous pressure is directly manifested throughout the intrarenal venous system. Intrarenal venous system is of particular importance in renal tumors. In various papers on angiography in renal tumors, a number of radiologists have described the presence of "radio-opaque substance lakes within the kidney" and suggested that they are in the abnormal vessels within the tumor. It is believed, however, that this explanation of the "lake" is unlikely to be correct because as the tumor grows, its heart tissue progressively remove peripheral vasculature, resulting in possible necrosis. Therefore, it is unlikely that the "lakes" can appear in new or altered vessels in the tumor itself. There have been experiments have shown that the "lakes"

appear in the venous phase and not in the arterial phase angiogram. It was suggested that as renal cell carcinoma is well known for early invasion of the venous system, tumor cells can spread easily in the kidney whose intrarenal veins have limited multiple segmental arches. In various places, the tumor cells can attach to the wall and can partially block the venous lumen. This, in turn, may cause local dilatation of thin-walled veins and blood flow through them will be slowed, thus appearing "lakes".I think this study is interesting not only morphological but also for the practitioner, internist, surgeon especially some aspects presented on the formation of renal veins, which may explain some of the causes of such complex pathology of the kidney.

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