Research Article

Study on variations in segmental branching pattern of renal artery

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Abstract

Introduction: With the increasing use of renal transplantation, segmental resection and renal reconstructive surgeries, knowledge of the variations in the segmental branching pattern of renal artery has grown in importance. **Material and methods:** In the present study carried out on 42 adult kidneys by dissection method, we found different types of variations in all the segmental branches of renal artery. **Results:** From Anterior division, apical segmental artery was seen to be taking origin in 23%, middle segmental artery in 67%, upper segmental artery in 42.% and lower segmental artery in 73% kidneys. Apical segmental artery took origin from upper segmental artery in 37% and from middle segmental artery in 3% kidneys. Middle segmental artery originated from upper segmental artery in 7% and from lower segmental artery in 23% cases. Posterior segmental artery was seen as conventional arching pattern in 57%, seen to be bifurcated or trifurcated in 30% and larger than anterior division in 10% kidneys. It was seen to be giving origin to other segmental branches variably. Renal artery and aorta were also seen to be contributing to these branches to a large extent. **Discussion:** Knowledge of segmental branching pattern of renal artery is having surgical importance in making a relatively bloodless surgical approach to the kidneys and to save healthy renal tissue in partial nephrectomy and nephrolithotomy.
Keywords: renal artery, branching pattern.

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INTRODUCTION

Renal arteries are a pair of lateral branches arising from abdominal aorta below superior mesenteric artery at the level of first lumbar vertebra. Renal artery divides into anterior and posterior divisions anywhere between aorta and renal hilum[1]

On the basis of branching pattern of renal artery, Graves[2] first described concept of segmental branches of renal artery. He described five segmental branches as apical, upper, middle, lower and posterior segmental arteries. Apical and lower segmental arteries supply both anterior and posterior surface of apical and lower segments. Upper segmental artery supplies anterior surface above hilum while middle one supplies anterior surface below hilum. Posterior segmental artery supplies whole of posterior surface except two poles. He made outstanding contribution to renal surgeries by describing segmental branches with a very little or no anastomosis. Knowledge of segmental branching pattern of renal artery is important in renal transplantation, renal surgeries as success of these surgeries depend on arterial ligations. Familiarity with arterial variations allows better access to segmental arteries at hilum level and safe laparoscopic partial nephrectomies. Segmental artery ligation reduces the risk for renal parenchyma to a minimum[3]. The present study on renal arterial segmental pattern and its variations was undertaken because of its urological importance for having a bloodless surgical approach to kidneys and to save healthy renal tissue in renal surgeries.

MATERIAL AND METHODS

In the present study, we studied 42 adult human kidneys by dissection method available in the department of Anatomy, Government medical college, Latur. Each

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formalin fixed kidney was washed in running tap water to remove formalin. Fat present at hilum was removed to see extrarenal branches of renal artery. Capsule was stripped off and parenchyma was removed in piecemeal with forceps. The branches of renal artery were traced through kidney substance to observe variations in segmental branching pattern and presence of collateral circulation if any.

RESULTS

Renal artery can be classified into various ways.

Depending on Mode of termination of anterior division of renal artery (Table no. 01)

Type I: terminates as upper and middle segmental arteries after giving off lower segmental artery **(fig. 02)**

Type II: terminates as middle and lower segmental arteries after giving off upper segmental artery

Type III: gives origin to apical segmental artery and then to three terminal branches as upper, middle and lower segmental arteries

Type IV: does not give origin to apical segmental artery but gives off three terminal branches as upper, middle and lower segmental arteries **(fig. 05)**

Type V: runs downwards with outward convexity from which segmental branches arise **(fig. 01)**

Type VI: terminates into middle and lower segmental arteries **(fig. 03)**

Depending on Mode of origin of Apical segmental artery (Table no. 02)

Type I: Origin from anterior division of renal artery **(fig. 01)**

Type II: Origin from upper segmental artery **(fig. 03)**

Type III: Origin from junction of anterior and posterior division or from middle segmental artery

Type IV: Origin from renal artery

Type V: Origin from aorta

Type VI: Origin from posterior segmental artery **(fig. 05)**

Depending on Mode of origin of Middle segmental artery (Table no. 03)

Type I: origin from anterior division of renal artery **(fig. 02)**

Type II: origin from upper segmental artery

Type III: origin from lower segmental artery

Type IV: Origin from renal artery

Type V: Origin from aorta

Type VI: Origin from posterior segmental artery **(fig. 04)**

Depending on Mode of origin of Lower segmental artery (Table no. 04)

Type I: origin from anterior division of renal artery **(fig. 02)**

Type II: Origin from posterior segmental artery

Type III: Origin from renal artery **(fig. 05)**

Type IV: Origin from aorta **(fig. 04)**

Posterior segmental artery (Table no. 05, Fig. 06)

Type I: conventional arching pattern

Type II: bifurcated or trifurcated at the hilum posterior to pelvis

Type III: relatively larger due to replacement of segmental arteries anterior division

In most cases (70.8%) branching of renal artery was prehilar. In 18.8% cases, it took place at hilum and in 10.4% cases, it was intrarenal.

Table 1: Depending on Mode of termination of anterior division of renal artery

Side	Type I	Type II	Type III	Type IV	Type V	Type VI
Right	13.33	16.66	3.33	3.33	6.66	-
Left	16.66	6.66	6.66	3.33	-	13.33
Total	**40**	**23.33**	**10**	**6.66**	**6.66**	**13.33**

Table 2: Depending on Mode of origin of Apical segmental artery

Side	Type I	Type II	Type III	Type IV	Type V	Type VI
Right	13.33	10	-	3.33	6.66	6.66
Left	13.33	16.66	3.33	13.33	3.33	10
Total	**26.66**	**26.66**	**3.33**	**16.66**	**10**	**16.66**

Table 3: Depending on Mode of origin of Middle segmental artery

Side	Type I	Type II	Type III	Type IV	Type V	Type VI
Right	20	-	16.66	-	-	3.33
Left	46.66	6.66	3.33	3.33	-	-
Total	**66.66**	**6.66**	**20**	**3.33**	**-**	**3.33**

Table 4: Depending on Mode of origin of Lower segmental artery

Side	Type I	Type II	Type III	Type IV
Right	23.33	-	16.66	6.66
Left	50	-	10	3.33
Total	**73.33**	**-**	**16.66**	**10**

Table 4: Posterior segmental artery

Side	Type I	Type II	Type III
Right	30	3.33	3.33
Left	30	26.66	6.66
Total	**60**	**30**	**10**

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

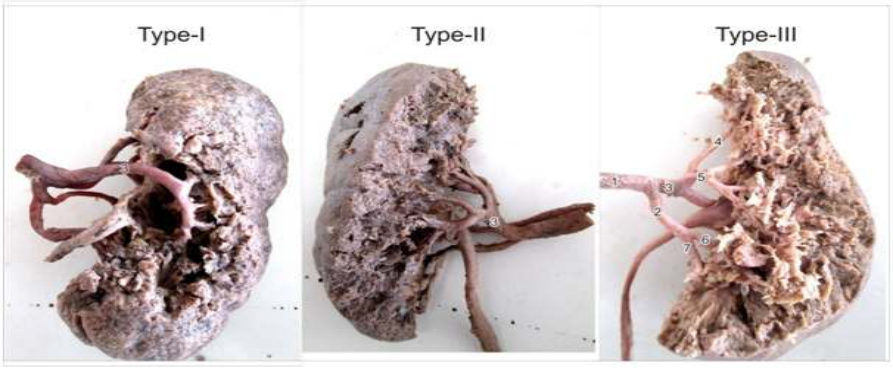

Figure 6

Legends

Figure 1: 1 Renal artery 2. Ant div 3. Posterior segmental artery (PSA) 4. Apical segmental artery (ASA) 5. Upper segmental artery (USA) 6. Middle segmental artery (MSA) 7. Lower segmental artery (LSA) 8. Superior polar artery (SPA)

Figure 2: ASA (4), SPA(8) from post div (3), USA(5), MSA(6), LSA(7) from ant div(2) of Renal artery(1).

Figure 3: ASA (4), USA(5), SPA(8) from post div (3) MSA(6), LSA(7) from ant div(2) of Renal artery(1).

Figure 4: ASA (4), LSA(7) from ant div(2) USA(5), MSA(6) from post div (3) Additional LSA(7a) from aorta.

Figure 5: ASA (4), SPA(8) from post div (3) USA(5), MSA(6), LSA(7) from ant div(2) of Renal artery(1). Additional LSA(7a) from Renal artery.

Figure 6: Types of posterior segmental artery. Type I: conventional arching pattern, Type II: bifurcated or trifurcated at the hilum, Type III: relatively larger due to replacement of segmental arteries of anterior division

DISCUSSION

Various studies have been carried out on segmental branching pattern of renal artery either by dissection[3,7,9,10,13], corrosion cast[2,8,12] or angiography[5,12]. In majority of cases, origin of segmental arteries is extra renal and is easily accessible. This is having importance as segmental resection is best carried out from hilum towards periphery. In the present study, in.70.8 % kidneys segmental arteries are seen extra renal and in only 10.4% their origin is intrarenal. The surgical accessibility to clamping of each presegmental and segmental artery from anterior and posterior approaches was determined by Weld[3]. The common variations in the blood supply to kidneys reflect the manner in which blood supply continually changed with developmental positions of kidney during embryonic and early foetal life[4]. Knowledge concerning variations in the renal vascular anatomy have assumed increasing importance as renal transplantation and other conservative methods in urological surgeries have become more common[5] The commonest complication encountered during partial nephrectomy is life threatening bleeding. Knowledge of variations in branching pattern of segmental arteries has reduced the mortality rate as various reconstructive surgeries like segmental resection have evolved to preserve healthy renal parenchyma[6]. No intrarenal arterial anastomosis are present and thus each artery supplying kidney represents an end artery and interruption of such is usually followed by infarction of that segment of renal parenchyma.[5] As there is no anastomosis in neighbouring segments, there will be neither ischemia nor interference in blood supply of segments other than the affected one.

This will make the segmental resection easier as field will be relatively bloodless after ligation of segmental artery.

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