

Renal Apical Segmental Artery Variations and Their Surgical Importance

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ABSTRACT

Objectives: The advent of more conservative methods in the renal and renal vascular surgeries has necessitated a more precise knowledge of renal vascularization and its importance in partial and total renal transplantation surgeries. Its main objectives: (a) To study the Intrarenal arterial segmental patterns especially the apical branch and its variations in 60 human kidneys by dissection, corrosion and radiological method, (b) To help the endourologic surgeons to carry out safer surgeries on kidneys, (c) To give reliable information to the anatomists for learning and teaching.

Methods: Totally 60 adult human kidneys were studied in the present work belonging to both sexes; Out of it 40 were procured from dissection cadavers in the Department of Anatomy, J.J.M. Medical College, Davanagere and 20 fresh kidneys from Mortuary, Chigateri General Hospital, Davanagere. Before removal of the kidneys from the bodies, possibilities of additional

apical renal segmental arteries from the common iliac, internal iliac, lumbar, sacral, superior mesenteric, hepatic and inferior suprarenal arteries were looked upon. The segmental arteries of the kidneys were studied by three methods i.e. 40 by dissections, 10 each by corrosion cast and radiological method.

Results: A total of 60 kidneys were studied, anterior division is classified into 8 types out of it Type VIII showed maximum of 20% and Type II of posterior segment 51.66%. The incidence of apical, upper, middle and lower remained the normal occurrence of 51.66%, 61.66%, 55% and 51.66% respectively.

Conclusion: Much importance is given to the segmental artery which arises in common and divides within the renal parenchyma, as healthy renal tissue is often involved during partial nephrectomy of the affected part during ligating the specified segmental artery.

Key Words: Human Kidneys, Intrarenal, Endourological surgeries, Arterial segmental pattern

INTRODUCTION

The present work on the intra-renal apical arterial segmental pattern of the human kidneys and its variations was undertaken because of its urosurgical importance in making a relatively bloodless surgical approach to the kidneys and to save the healthy renal tissue in partial nephrectomy. The advent of more conservative methods in renal surgery has necessitated a more precise knowledge of renal vascularization and its importance in partial and total renal transplantation surgeries.

Renal vascular segmentation was originally recognized by John Hunter [1] but the idea of segmental anatomy started with the discovery of bronchopulmonary segments by William Ewart [2]. In 1954, F. T. Graves [5] made an outstanding contribution to renal surgeries when he described five segmental branches. Riches [3], Abehouse and Lerman advised renal angiography prior to all the endourological surgeries. Robert [4] and D. Sykes stressed the necessity of knowing the variation in the vascular segmental patterns to prevent the avoidable loss of the normal healthy renal tissue which occurs in total nephrectomy, while the infarcted renal tissue is being removed. Thus, from radical total nephrectomy to conservative partial nephrectomy. The classification which has been adapted here is based mainly on the classification of the various types of the renal segmental arteries which have been made by others and these have been compared.

MATERIALS AND METHODS

The segmental arteries of the kidneys were studied by three methods, 40 specimens were studied by the dissection method and 10

specimens each were studied by the corrosion cast and radiological methods.

For these methods, after identifying the supernumerary renal arteries from the aorta, the kidneys of each pair were separated along with the renal arteries by discarding the piece of the aorta. Before the removal of the kidneys from the bodies, the possibilities of additional renal arteries, especially to the apical region, were looked upon as arising from other sources.

1. THE DISSECTION METHOD: Adult human kidneys from the dissection cadavers were washed and the parenchymatous tissue was removed in piece meal, while tracing the apical and the other segmental arteries as much as possible.

2. THE CORROSION CAST AND THE RADIOLOGICAL METHOD: Fresh kidneys, along with their capsules and the blood from the arteries and veins were washed off by injecting warm saline till a clear fluid came out of them and later, the fluid was drained completely. Through the narrow end of the silicon gum in the stem of the renal arteries, a material was injected slowly till complete resistance occurred and later, the stem of the artery was tightly tagged. It was kept overnight for drying and then it was immersed in HCl for 6 hours. After the soft tissue corrosion was complete, the resulting silicon cast was washed and dried.

For the radiological method, barium sulphate was injected through the renal artery and a radiograph was taken. The same kidneys were later dissected, the arterial patterns were compared and the findings were confirmed by comparing them to those which were seen in the radiographs.

RESULTS

(The results and observations which were made on the apical segmental artery) As the apical artery mainly arises from the anterior division of the renal artery, a brief study on the anterior division was also made along with that on the apical segmental artery. The following is the classification which was followed in this work and the total number of specimens which were observed:

Totally, 8 types of the anterior division of the renal artery were described, depending upon the mode of its branching and the results are shown graph 1.

(A) 6 TYPES OF THE APICAL SEGMENTAL ARTERIAL VARIATIONS ARE SHOWN BELOW:

Type I: (51.66%) It arose from the anterior division of the renal artery, along with most of the other segmental arteries. Type II:(25%) It arose from the upper segmental artery. Type III: (1.66%) It arose at the junction of the anterior and the posterior divisions of the renal artery or with the middle segmental arteries. Type IV: (11.66%) It arose from the renal artery much before its division into the other segmental arteries. Type V: (1.66%) It arose from the aorta (superior accessory renal artery). Type VI: (8.33%) It arose from the posterior division of the renal artery.

(B) THE POSTERIOR DIVISION

Due to the possibilities of the apical artery arising from the posterior segment or the divisional artery, the posterior division was also studied. In the present work, 4 types of posterior divisions were seen, but out of these, only the type III (16.66%) artery was found to give rise to the apical branch. i.e. The posterior division gives off either the (a) apical or (b) middle or the (c) lower segmental artery or any two of them, which usually are all branches of the anterior division. It supplies the posterior segment before or after giving the above said branches.

Workers	F.T. Graves	Kher et al	Present study
Year	1954	1960	2007
Kidneys Studied	-	54	60
Types - I	33.3%	33.3%	10%
II	30%	38.8%	11.66%
III	16.6%	27.3%	13.33%
IV	-	-	16.66%
V	-	-	6.66%
VI	-	-	15%
VII	-	-	20%
VIII	-	-	6.66%

[Table/Fig-1]: Showing comparative study on the anterior division of the renal artery

Workers	F.T. Graves	Servo	Kher et al	Verma et al [5]	Chatterjee et al	Singh et al	Present study
Years	1954	1959	1960	1961	1963	1967	2007
Kidneys studied	-	100	54	98	50	60	60
Type I	43.03%	Most frequent	45.28%	20.45%	42.2%	70%	51.66%
Type II	23.03%	-	15.05%	Absent	22%	-	25%
Type III	23.03%	18%	5.66%	16.3%	5%	-	1.66
Type IV	10%	5%	1.86%	29.7%	Absent	16.7%	11.66%
Type V	-	-	2.45%	-	-	-	1.66%
Type VI	-	-	29.7%	-	-	-	8.33%

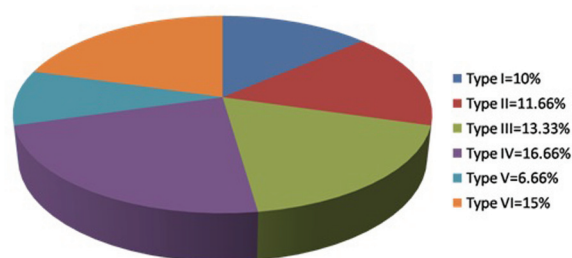
[Table/Fig-2]: showing comparative study on the apical segmental artery

DISCUSSION

The advent of more and more conservative methods in the field of endourological surgeries has necessitated a precise anatomical knowledge on the renal segmentations and their vascular patterns. The knowledge on these also help in knowing the renal function by noting the amount of renal perfusion which is caused by the arteries to that of amount of urine which is formed from the collecting system.

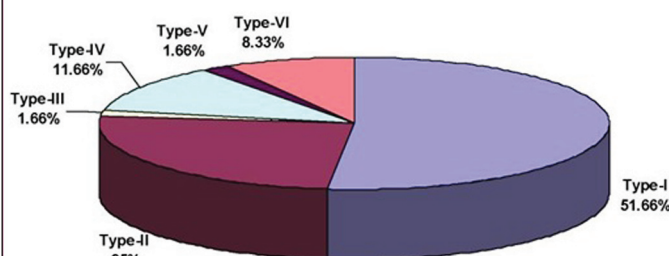
The description of Brodel's line in 1901 has revolutionized the renal surgeries since then. Since that time, a variety of complex renal reconstructive procedures have evolved for preservation of the renal parenchyma as an alternative to simple or radical nephrectomy. As a result, the urologic surgeons and anatomists may be called

Graph – 1 ANTERIOR DIVISION OF THE RENAL ARTERY



[Table/Fig-3]: Anterior Division Of The Renal Artery

Graph -2 APICAL SEGMENTAL ARTERY



[Table/Fig-4]: Apical Segmental Artery

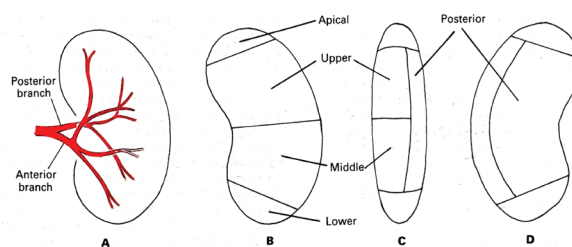
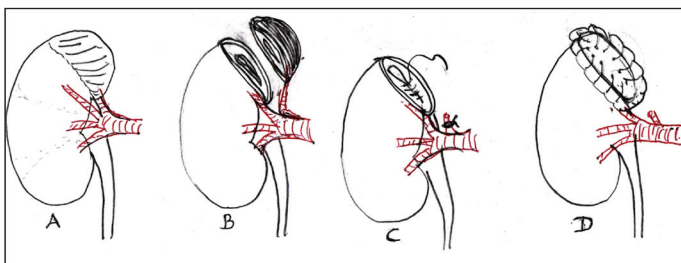


Fig. Arterial segments of the left kidney. A shows branches of the renal artery; B, C and D indicate the segments as seen from the front, the lateral side and the back respectively. The posterior division of the artery supplies the posterior segment and the anterior division supplies the other four. There may be variations in the pattern of division but the segments are constant.

[Table/Fig-5]: Showing the normal arterial segmentations



[Table/Fig-6]: 2A showing Anterior division & Apical renal segmental Arteries And showing anterior division & Apical Renal Segmental Arteries



[Table/Fig-7]: Showing partial apical segmental resection.

upon to perform these complex renal preservation procedures in the presence of trauma, neoplasia and urolithiasis. The new techniques which are employed in renal surgery mainly depend upon the segmental resection, namely the wedge-type resections, if the disease affects the upper or the lower segments. But for the mid-portion lesions, either the enucleation technique or partial nephrectomy is indicated, although they are obviously limited to the tumours and they may be employed in other conditions in which there is a minimal loss of the renal functions.

The lack of arterial anastomosis in the neighboring segments will affect only the affected segment and it will neither produce ischaemia nor interfere with the blood supply of the neighbouring segments. This lack of the arterial anastomosis will render the technique of the resection easier, since the field of operation will be relatively bloodless, following the ligation of the segmental artery which supplies the area of the operation. It should be remembered that the origins of the segmental arteries are accessible. In a majority of the cases, they are easily seen in the hilum and they are often at the points which are nearer the aorta. This is of practical value, since the segmental resection is best carried out from the hilum towards the periphery. In the type II cases, sometimes the surgeons may have to sacrifice even the healthy upper segmental branch and the soft tissue. The type III cases create more difficulty for the

surgeons in the ligation of this segmental branch and in the resection of the artery along with the soft tissue, as ligating may cause disturbances in the neighbouring segments. In the type V cases, the inferior suprarenal artery may arise from the superior accessory renal artery. Type VI: Most of the times, in the type VI cases, the apical artery arises from the posterior division and this makes it easier for the surgeons to do ligations of the segmental artery which supply the apical region. The apical segmental artery and its variations as per our findings, are shown in Table 2 and these have been compared with others.

CONCLUSIONS

The advent of more and more conservative methods in the field of renal surgery has necessitated a more precise knowledge on renal vascularization and its importance in partial and total renal transplantation surgeries. Therefore, the valuable contribution of this anatomical knowledge to operative surgeries, particularly in the partial or segmental resection of the kidneys, will help in the further development of different techniques for the removal of calculi or any affected part of the kidneys. This will also help in partial renal transplantation surgeries with end to end anastomosis of the resected part of the kidney.

The presence of the arterial segments within the substance of the kidney does not change, but there is a lot of variation in their course and in the exact point of origin of these segmental vessels from the renal artery or the aorta outside the substance of the kidney. After the advent of the renal segments, the urological complications which followed partial nephrectomy have considerably reduced. Nephrectomy or the total removal of a kidney will no longer be performed, if a lesser procedure can offer a better prospect. Every fragment of the healthy, functional renal tissue should be preserved, provided that it has an arterial supply, a venous drainage, and a urinary exit or a collecting system and provided that expertise is available to preserve the healthy fragment.

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