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ARTERIAL SEGMENTATION OF HUMAN KIDNEYS

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ABSTRACT

Objectives: Awareness about variations in renal morphology is indispensable for a surgeon doing partial nephrectomy and segmental renal resections. The advent of conservative surgical methods in renal surgery has necessitated a more precise knowledge. The aim of this study was to establish and demarcate the arterial segments of the human kidney.

Methods: The study was carried out on fifty kidneys, from adult human cadavers. They were treated with 5% "Potassium hydroxide" solution for 72 hours prior to dissection. Dissection of the kidneys was done meticulously keeping in mind the orientation of poles, borders and surfaces. The branches of renal arteries were traced through the kidney substance and the renal segments were demarcated according to the segmental arteries.

Results: Twenty five kidneys (50%) showed five arterial segments. Fifteen kidneys (30%) showed four segments, five kidneys (10%) showed three segments, four kidneys (8%) showed six segments and one kidney (2%) showed only two segments. The area of distribution on anterior and posterior surfaces showed varied patterns.

Conclusion: Considering the significance of knowledge of renal vascular patterns in conduct of various renal surgeries and in interventional radiology, conservative surgery and oncologic surgery, it was thought necessary to reassess the pattern of arterial segmentation in the human kidney. Keeping in mind the ever evolving knowledge and yet unexplained facts of the subject, this study was undertaken.

Keywords: Renal vascular pattern, arterial segmentation, conservative surgeries, segmental resection

INTRODUCTION

The concept of renal vascular segmentation was first recognized and mentioned by John Hunter.¹ However the present day concept of segmental arterial supply of kidney is based on the work of Graves.² In his study, conducted on more than thirty kidneys by cast method and angiography, the renal parenchyma was divided into five segments on the basis of segmental arteries. They were named as apical, upper, middle, lower and posterior segments. The apical and lower segments were common on both anterior and posterior surfaces. However

variations to this pattern exist, hence a detailed study of renal morphology becomes essential. This is of value in nephro-lithotomy and segmental resections of the kidney.

As per literature, renal segmental arteries are end-arteries.³ From the clinical point of view, occlusion of a segmental artery causes necrosis of a supplied segment that would cause absence of functionally essential junctions. However, surgeons confirm frequent difficulties with hemostasis during segmental renal resection, which are not always explicable by a blurred limit of segments, collateral circulation from capsular

anastomoses or by imperfections in surgical techniques.⁴Intrarenal arterial collateral circulation may develop in cases of renal artery stenosis or occlusion as demonstrated by angiographic studies.⁵⁻⁸

MATERIAL AND METHODS

The study was carried out on fifty kidneys from formalin preserved adult cadavers. They were treated with 5% "Potassium hydroxide" solution for 72 hours prior to dissection. This made the renal tissue soft and facilitated the tracing of arteries through the substance of kidney. Dissection of the kidneys was done meticulously keeping in mind the orientation of poles, borders and surfaces. The branches of renal arteries were traced through the kidney substance and renal segments were demarcated. Segmental arteries were said to be those branches which were arising from renal arteries or accessory arteries outside the hilum of kidney. The segments were delineated depending on the number of segmental arteries. The variations in the number and position of segments were observed and noted. The kidneys were preserved in 10% formalin solution after the dissection.

RESULTS

Twenty five kidneys (50%) showed five arterial segments. However the number of segments varied from two to six. The area of distribution on anterior and posterior surfaces showed varied patterns. On the posterior surface a nil segment was considered where a separate segmental artery was not seen, and it was presumed that, rest of the posterior surface was supplied by corresponding anterior segmental artery through the renal substance.

DISCUSSION

Anatomically the kidney is divided into five arterial segments- apical, upper (anterior), middle (anterior), lower and posterior, depending upon the number of segmental arteries³. "As there is no

constant arterial segmental pattern of the kidney, it may often not be possible to forecast beforehand the type of partial nephrectomy which might or might not be possible in a particular case. Very often the decision to perform a segmental resection of the kidney shall have to be taken on operation table by surgeon after exploration of kidney or before operation by angiography. But it may be of importance for surgeon to be acquainted with different types of cases that are unsuitable for segmental resections and this will put the surgeon on guard to exercise greater cautions.⁹

The work of Roberts¹⁰ and Chatterjee AK¹¹ supported the conventional segmentation of human kidney into five segments, whereas Sykes¹² showed 83.1% kidneys to have five segments and 8.4% kidneys to have three segments. Some authors have reported as few as three arterial segments¹³ and also as high as seven arterial segments.¹⁴ However Hegedus¹⁴ has stated that a strict division of the kidney into segments is not possible.¹⁵

The present study showed a variation ranging from two to six segments. These findings correspond to the earlier studies. Sapte & Bordei¹⁶ reported five segments in 42.7% kidneys, four segments in 39.6%, three segments in 10.8% and six segments in 6.7% kidneys. Longia et al¹⁷ showed a slight variation as five arterial segments were seen in 53% kidneys, four segments in 46% and three segments in 1% kidneys. Sampaio¹⁸ reported five segments in 61.2% kidneys and four segments in 38.8% kidneys.

"Intra renal collaterals at capsular, inter-lobar or arcuate arteries have been documented on occlusion of the main artery or in cases of renal artery stenosis."⁵⁻⁸

CONCLUSION

The knowledge of renal vascular patterns in conduct of various renal surgeries, interventional radiology, conservative surgery and oncologic surgery is of great importance. Variations in the

arterial segments of the kidney are significant for the surgeons performing partial nephrectomy operations to aid renal tissue preservation.

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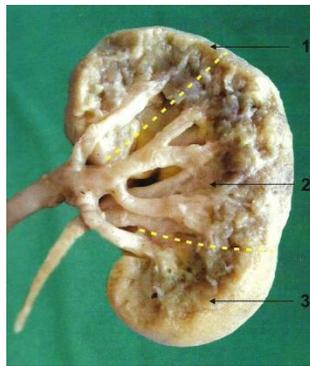
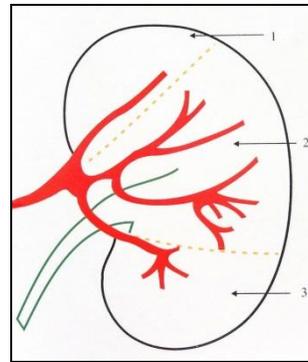
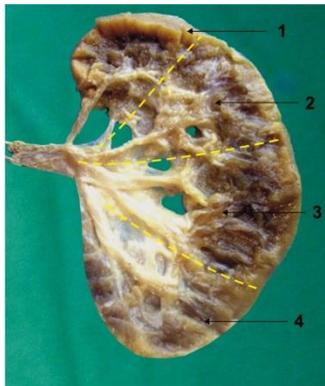
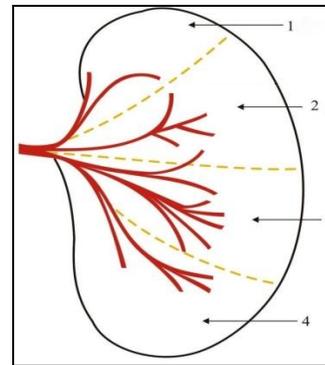
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Table1: Incidence and Distribution of segments on anterior and posterior surfaces of kidneys

Total No. of arterial segments	No. and % of kidneys	No.ofsegments onanterior surface	No.ofsegments on posterior surface	No. and % of kidneys of the pattern
5	25kidneys (50%)	two patterns 4 3	1 2	20kidneys (80%) 5kidneys(20%)
4	15 kidneys (30%)	one pattern 3	1	15 kidneys (100%)
3	5kidneys (10%)	two patterns 3 2	nil 1	3kidneys (60%) 2 kidneys (40%)
6	4kidneys (8%)	three patterns 4 3 5	2 3 1	2kidneys(50%) 1kidneys(25%) 1kidneys(25%)
2	1 kidney (2%)	one pattern 2	nil	1 kidney(100%)

**Fig 1: Shows three arterial segments on the anterior surface of kidney****Fig 2: Schematic representation of Fig 1****Fig 3: Shows four arterial segments on the anterior surface of kidney****Fig 4: Schematic representation of Fig 3**

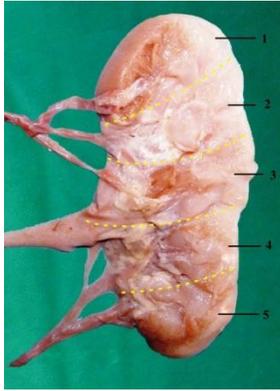


Fig 5: Shows five arterial segments on the anterior surface of kidney

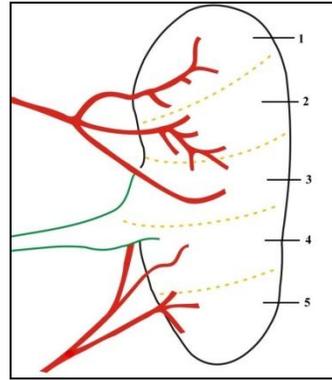


Fig 6: Schematic representation of Fig 5