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Original Research Article

STUDY OF ARRANGEMENT OF RENAL HILAR STRUCTURES IN HUMAN CADAVERS

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ABSTRACT

Background: Renal hilum is the middle concavity of the medial border of kidney which communicates with renal sinus. The disposition of renal hilar structures has been described in anatomical textbook from anterior to posterior as the renal vein, renal artery and renal pelvis. Variations in arrangement of renal hilar structures were detected incidentally while performing investigative imaging and angiographic procedures. Anatomical knowledge of structures at the renal hilum is of great importance for various urological surgical procedures and also during interpretation of various radiological techniques related to the kidney.

Objective: To evaluate the arrangement of renal hilar structures in human cadavers

Materials and Methods: Present work was carried out in the Department of Anatomy, Sri Devaraj Urs medical college, Kolar on fifty pairs of morphological normal kidneys of embalmed cadavers. Renal hilum of each kidney was dissected carefully to see the arrangement of renal artery, vein and pelvis and their anteroposterior relations at the hilum were recorded.

Results: The arrangement of renal hilar structures exhibited great variations. The patterns of arrangement of the hilar structures were classified into 12 major patterns. In 32 % kidney we observed the classical arrangement of hilar structures described in standard textbooks as renal vein, renal artery and pelvis. In 36% cases anterior trunk of renal artery is the most anteriorly placed structure at the renal hilum. In 21% cases we observed anterior and posterior tributaries of renal vein. The renal pelvis in between the divisions of renal artery and tributaries of renal vein was noted in 43% cases. We noticed the formation of the renal pelvis outside the hilum in 7% cases.

Conclusion: Present study will help to provide better knowledge of disposition of renal hilar structures which will be useful for the urological surgeons, radiologists and anatomists.

KEY WORDS: Kidney, Renal hilum, Variation, Nephrectomy.

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INTRODUCTION

The kidneys are a pair of chief excretory organs which secrete the end products of metabolism and maintain the electrolyte and water balance. They also serve as endocrine organs by releasing erythropoietin which affects red blood cell formation and renin which influences blood pressure. Renal hilum is the middle concavity of the

medial border which communicates with renal sinus. The hilum of the right kidney lies just below, and of the left just above, the transpyloric plane 5 cm from the midline. The hilum of the kidney leads into a central sinus, lined by the renal capsule and almost filled by the renal pelvis and vessels, the remaining space being filled by fat [1]. Classically, the disposition of renal hilar structures has been described in anatomical textbooks from anterior to posterior as the renal vein, renal artery and renal pelvis [1,2].

The precise knowledge of normal and variant anatomy of structures at the renal hilum is mandatory prior to any surgical intervention of the kidney such as in conventional and laparoscopic nephrectomy, nephrolithotomy, pyelolithotomy and renal transplantation[3]. Surgeons who perform endopyelotomies should be aware of arrangements of the structures at the renal hilum as they have to perform hilar dissection. Dissection into hilar region can be challenging but is important in surgery on the renal pelvis, particularly open stone surgery.

Nephrectomy is being used as a choice of a therapeutic procedure towards certain kidney disorders in which the functional units of the nephrons are spared [4]. A Laparoscopic Partial Nephrectomy (LPN) procedure is a very complicated and a technically challenging task for the urologists, as it requires the skill of ligation or clamping of the vessels which are present in the narrow spaced hilum [5]. However, clamping of the individual structures is beneficial than the en-bloc clamping procedures [6]. Hence, it is necessary to have an ample knowledge on the arrangements of the renal hilar structures before making a surgical approach, as these arrangements and the number of structures in the hilum are highly variable than the actual patterns which are given in the standard text books.

A systematic study with the specific focus on the arrangement of structures at the renal hilum, has seldom been reported in literature. Usually, the variations in arrangement of renal hilar structures were detected incidentally while performing investigative imaging and angiographic procedures. However, there are very few detailed anatomical studies about the main renal hilar structures in Indian population. Considering the importance of arrangement of renal hilar structures during urological surgery and renal transplant, we evaluated the arrangement of main renal hilar structures in Indian population.

Our study aims to evaluate the anatomical disposition of the main renal hilar structures, consisting of the renal artery, vein and pelvis, in adult human cadavers, considering the antero-posterior distribution.

MATERIALS AND METHODS

The study was conducted in the Department of Anatomy, Sri Devaraj Urs medical college, Kolar on 100 (50 Right [R] and 50 Left [L]) morphological normal kidneys of embalmed cadavers. Renal hilum of each kidney was dissected meticulously. After careful dissection, the arrangement of renal hilar structures was analyzed approximately 0.5 cm from the anterior lip of the renal hilum. The division patterns of the renal vessels, just before they entered the corresponding hilum, were examined carefully. This was then followed by the observation of their arrangements in the hilum and their correlation with the renal pelvis. Antero-posterior relations of structures at renal hilum were noted and classified into various patterns.

RESULTS

Table 1: Shows arrangement of structures at renal hilum in 12 patterns.

Pattern	Arrangement of structures at Renal Hilum (Anterior to posterior)	Right side (n=50)	Left side (n=50)	Total number of Kidneys (n=100)
1A	RV-RA-P	18	14	32
1B	RV-AD-PD-P	4	4	8
2	AD-RV-PD-P	5	9	14
3	AT-AD-P-PT-PD	-	2	2
4	RV-AD-P-PD	5	7	12
5	AD-RV-P-PD	2	6	8
6	AD-AT-P-PD-PT	3	6	9
7	AT-AD-PT-PD-P	2	1	3
8	AT-AD-PT-P-PD	2	-	2
9	AD-AT-PT-P-PD	3	2	5
10	RV-P-RA	1	1	2
11	RA-RV-P	1	2	3

[RV-Renal vein, RA-Renal artery, P- Renal Pelvis, AD-Anterior division of Renal artery, PD- Posterior division of Renal artery, AT- Anterior tributary of Renal vein, PT-Posterior tributary of Renal vein]

The arrangement of renal artery, renal vein and the pelvis, antero-posteriorly exhibited great variation in their relation at the hilum. We classified the different arrangement of the hilar

structures into 12 patterns. The arrangement of renal hilar structures in 12 patterns and their percentages of occurrence have been shown in [Table-1].

Out of 100 kidneys studied we observed classical pattern of disposition of renal hilar structures described in standard textbooks from anterior to posterior as renal vein, renal artery and renal pelvis in 32%. In 63 % of the cases the renal artery divided into anterior and posterior division. In 36% cases anterior trunk of renal artery is the most anteriorly placed structure at the renal hilum. In 21% cases we observed anterior and posterior tributaries of renal vein. The renal pelvis in between the divisions of renal artery and tributaries of renal vein was noted in 43% cases. We noticed the formation of the renal pelvis outside the hilum in 7 kidneys out of the 100 kidneys which were studied.

Fig. 1: Pattern 1B- Renal vein(RV), Anterior division of Renal artery(AD), Posterior division of Renal artery(PD), Renal Pelvis(P).

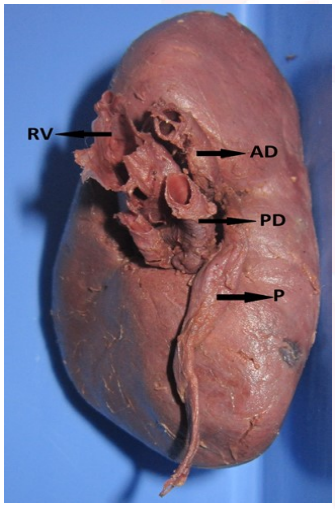
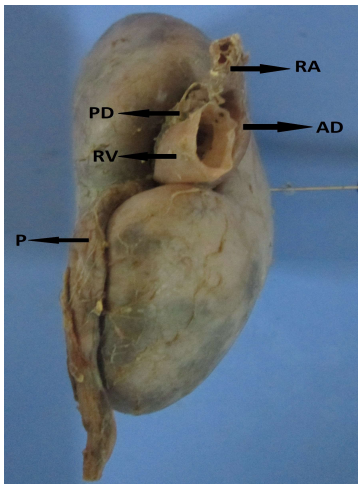


Fig. 2: Pattern2- Anterior division of Renal artery(AD), Renal vein(RV), Posterior division of Renal artery(PD), Renal Pelvis(P).



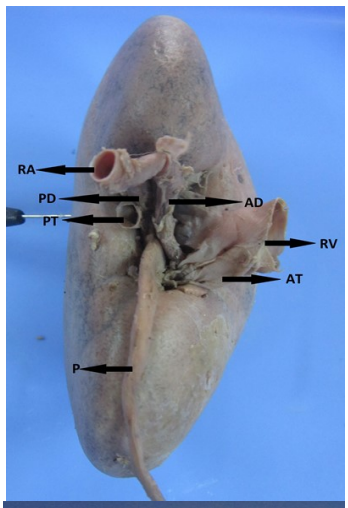


Fig. 3: Pattern 3- Anterior tributary of Renal vein(AT), Anterior division of Renal artery(AD), Pelvis(P), Posterior tributary of Renal vein(PT), Posterior division of Renal artery(PD).

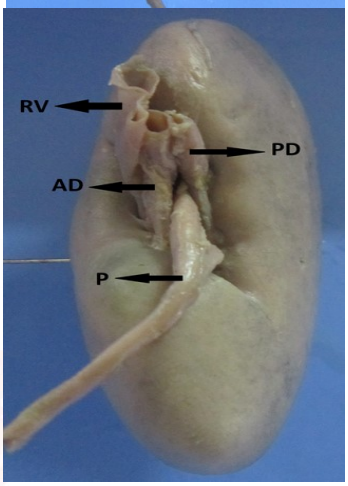


Fig. 4: Pattern 4- Renal vein(RV), Anterior division of Renal artery(AD), Pelvis(P), Posterior division of Renal artery(PD).

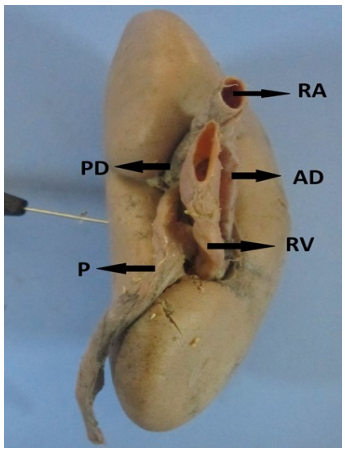


Fig. 5: Pattern 5- Anterior division of Renal artery(AD), Renal vein(RV), Pelvis(P), Posterior division of Renal artery(PD).

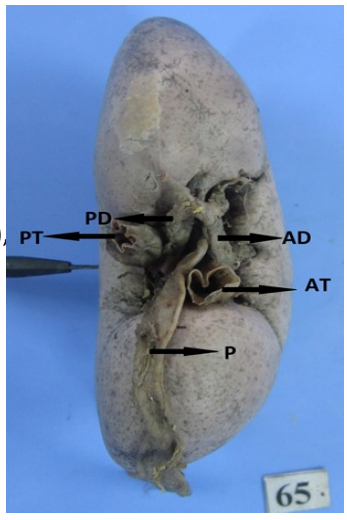


Fig. 6: Pattern 6- Anterior division of Renal artery(AD), Anterior tributary of Renal vein(AT), Pelvis(P), Posterior division of Renal artery(PD), Posterior tributary of Renal vein(PT).

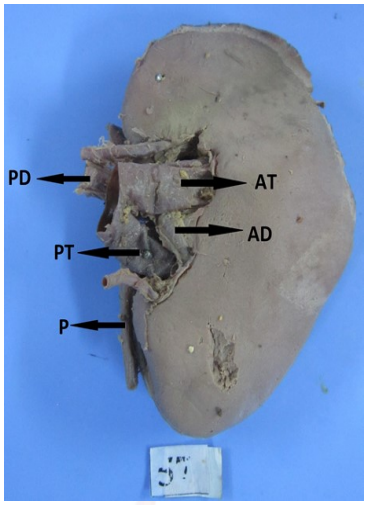


Fig. 7: Pattern 7- Anterior tributary of Renal vein(AT), Anterior division of Renal artery(AD), Posterior tributary of Renal vein(PT), Posterior division of Renal artery(PD), Pelvis(P)

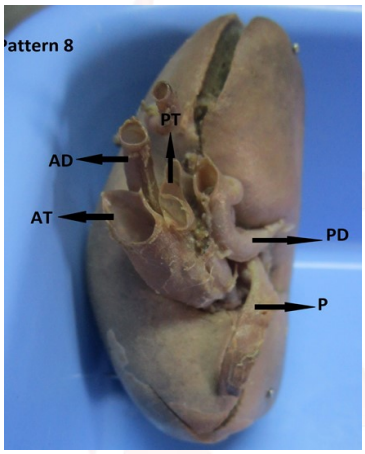


Fig. 8: Pattern 8- Anterior tributary of Renal vein(AT), Anterior division of Renal artery(AD), Posterior tributary of Renal vein(PT), Pelvis(P), Posterior division of Renal artery(PD).

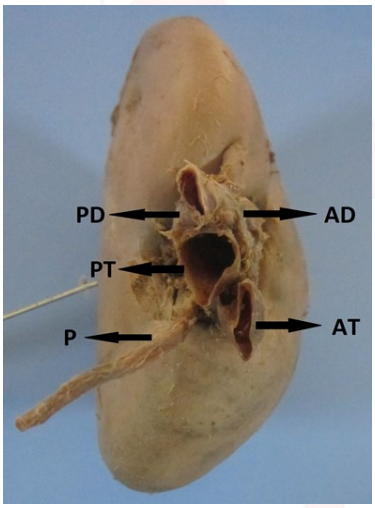


Fig. 9: Pattern 9- Anterior division of Renal artery(AD), Anterior tributary of Renal vein(AT), Posterior tributary of Renal vein (PT), Pelvis(P), Posterior division of Renal artery(PD).

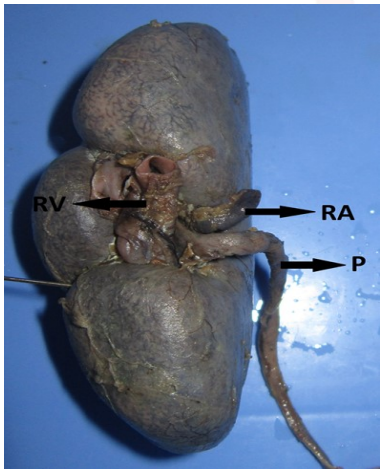


Fig. 10: Pattern 10- Renal vein(RV), Pelvis(P),Renal artery(RA).

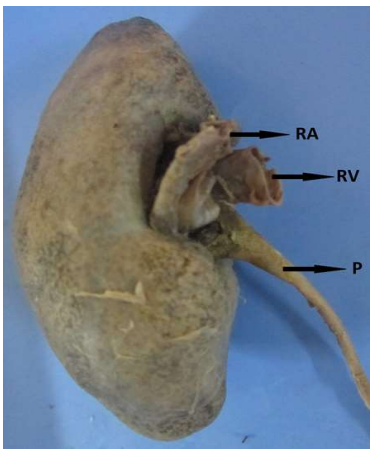


Fig. 11: Pattern 11- Renal artery(RA), Renal vein(RV), Pelvis(P).

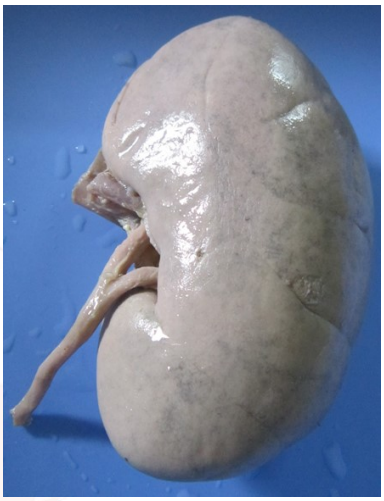


Fig. 12: Formation of renal pelvis outside the renal hilum.

DISCUSSION

Possessing the knowledge on the distribution of the renal hilar structures is of crucial importance for urological surgical procedures which involve the hilar vessel clamping. Therefore, a prior knowledge on various possibilities of the branching patterns of the renal vessels in the hilar region, as well as their topographic arrangements, come in handy for the urologists before they perform various surgical procedures in the hilar region[7]. Many researchers studied the renal vessels at peri-hilar and hilar region but there are very few reports about the arrangement of renal hilar structures.

We classified the arrangement of renal hilar structures into 12 patterns. The normal anatomy of arrangement of renal hilar structures is described in pattern 1A while rest of the pattern described the variation in disposition of renal hilar structures. The results of the our study were compared with similar previous studies which were done on the patterns of the hilar structures as shown in Table 2.

It is noted that, each study shows variable number of patterns and incidence which may be

Table 2: Comparison of pattern of arrangement of renal structures in the hilum with other previous studies.

Pattern	Joao et al. [8] (Brazil)	Trivedi et al.[9] (India)	Naveen Kumar et al.[10] (India)	Jadhav.S et al.[11] (India)	Present study
RV-RA-P	83%	19%	45.80%	22.80%	32%
RV-AD-PD-P	-	8%	-	9.64%	8%
AD-RV-PD-P	-	23%	2.10%	5.26%	14%
AT-AD-P-PT-PD	-	22%	2.10%	-	2%
RV-AD-P-PD	-	20%	8.30%	7.89%	12%
AD-RV-P-PD	-	8%	4.20%	20.17%	8%
AD-AT-P-PD-PT	-	-	-	21.05%	9%
AT-AD-PT-PD-P	-	-	-	3.50%	3%
AT-AD-PT-P-PD	-	-	-	5.26%	2%
AD-AT-PT-P-PD	-	-	-	2.63%	5%
RV-P-RA	3%	-	2.10%	-	2%
RA-RV-P	3%	-	28.10%	-	3%

because of anatomic variations of renal vessels which are common in general population with different frequencies among several ethnic and racial groups.

Present study observed that variant patterns are more common on left side which is in favor of other studies [9-11]. Embryologically the right renal vein develops from a single anastomotic channel whereas the left renal vein develops from multiple anastomotic channels. Hence the predominant left sided occurrence may have an embryological explanation. Developmental malformations may change the interrelationship of the hilar structures.

The present study has demonstrated that in majority of cases branches and tributaries of renal vessels occupy the prehilar and hilar region rather than the main trunks of renal vessels. This observation is supported by various studies conducted by Sampaio et al. on vascular relationship of uretropelvic junction which concluded that in the majority of cases a branch of renal artery and/or venous tributaries lies in close proximity of the pelvis implying prehilar branching of renal artery [12-14].

A different variant pattern of disposition of renal hilar structures makes the crowding of structures at renal hilum and it may confusesurgeon and pose difficulty during surgical dissection at hilar region and it may produce iatrogenic trauma to these structures and create emergency during surgery especially during laparoscopic partial nephrectomy. Therefore it is essential to have a detailed knowledge of renal hilar structures[15].

Surgical interventions that require hilar dissections are technically more challenging in laparoscopic approach as compared to open surgeries[16,17]. For many operations on the kidney including Nephron sparing surgeries like partial nephrectomy by laparoscope is treatment of choice and in this surgery hilar dissection is one of the important steps. In cases of renal hilar tumors laparoscopic partial nephrectomy is being done with a limited field of vision. Knowledge of renal hilar structures variations is useful for operating surgeons to identify and individually clamp the hilar structures, which is advantageous over en-bloc clamping.

Knowledge of branching pattern of the renal artery is very important for the proper analysis of radiographic interpretation of renal vasculature and for planning surgical procedures in cases of renal trauma, renal transplantation, and partial nephrectomy[18].The variations in the branching patterns of the renal vessels are critical issues and a challenging task for a radiologists who interpret renal angiograms and for the urologists who perform laparoscopies [19].

Several studies have reported that anomalous courses of the renal vessels which had crossed the renal pelvis, caused ureteropelvic obstructions[20,21]. The most reliable reason for the extrinsic obstruction which is caused by a renal vessel could be an incomplete rotation of the kidney [22]. Rotational defects of the kidney is

one of the common cause for anomalous arrangement of renal hilar structures[23].

Anatomical variants of renal hilar structures, as described in the present study, have not received much attention in standard texts of anatomy but have only been encountered during routine cadaveric dissections.

In conclusion (i) In approximately two third cases the arrangement of hilar structures does not conform the normal description (i.e. vein, artery and pelvis); (ii) Variant patterns are more commonly seen on left side; (iii) In approximately one third cases, anterior trunk of renal artery is the most anteriorly placed structure at the renal hilum.

CONCLUSION

An anatomical knowledge on the various possibilities of the branching patterns of the renal vessels in and adjacent to the hilar region, as well as their unusual patterns of arrangement are of utmost importance for the urologists before they perform any kind of surgical procedures which pertain to the kidney, and also helpful for radiologist during interpretation of various radiological techniques related to the kidney and physician to understand pathophysiology of renal disease.

We conclude from present study that, arrangement of structures at renal hilum are highly variable than the classical pattern which is given in the standard textbooks of anatomy. The present study may contribute to a better knowledge of the topographical organization of the renal hilum, which is a region frequently involved in surgical dissection during urological surgical procedures of the kidney.

Conflicts of Interests: None

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