International Journal of Research in Medical Sciences
Dawani P et al. Int J Res Med Sci. 2021 Oct;9(10):3039-3042
www.msjonline.org
pISSN2320-6071 | eISSN2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20213929

Original Research Article

Anatomical study on variable disposition of structures in the renal hilum

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Received: 19 August 2021
Revised: 10 September 2021
Accepted: 14 September 2021

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ABSTRACT

Background: The hilum is a deep vertical fissure present anteromedially in the kidney, and contains renal vessels and pelvis. Due to advancements in imaging techniques; nephron sparing surgeries like laparoscopic partial nephrectomy have become more common. In these procedures, only specific branch of renal artery, and tributary of renal vein are ligated in the renal hilum. This requires adequate skill of the surgeon as the structures are crowded in the renal hilum. The knowledge of arrangement of renal hilar structures is also important for radiologists to correctly interpret renal angiograms and other radiological scans.
Methods: The present study was conducted in the department of anatomy, Vardhman Mahavir medical college, New Delhi on 64 kidneys derived from embalmed human cadavers. The renal hilum was dissected and the sequence of structures from anterior to posterior direction was noted.
Results: The kidneys were classified in 6 patterns, with the classical pattern (renal vein, artery and pelvis from anterior to posterior) observed in 37.5% cases only. Remaining 62.5% cases exhibited variations, of which the pattern 2 (V-A1-P-A2) was seen in maximum cases (26.5%).
Conclusions: The classical pattern described in anatomical textbooks is not the only pattern of arrangement of renal hilar structures. Instead, variant patterns are commonly encountered. The present study attempts to elucidate the variant anatomy of the renal hilar region to help radiologists and surgeons in proper diagnosis and treatment.

Keywords: Renal hilum, Renal vessels, Renal pelvis, Laparoscopic, Nephrectomy

INTRODUCTION

The kidneys, a pair of retroperitoneal organs, are chiefly excretory in function. They also serve endocrine functions by producing erythropoietin and renin. Superiorly, they are level with the twelfth thoracic vertebra and inferiorly, with the third lumbar vertebra.[1]

The renal hilum is a deep vertical fissure that opens anteromedially bounded by anterior and posterior lips and containing renal vessels, nerves and renal pelvis. On the right side, it lies just below, and on the left side, it lies just above the transpyloric plane, 5 cm from the midline. The classical arrangement of renal hilar structures as described in anatomical textbooks is renal vein, artery and pelvis, from anterior to posterior.[1,2] Conventional and laparoscopic nephrectomy, nephrolithotomy and renal transplantation are commonly performed surgical procedures on kidney. Now a days, partial nephrectomy is a preferred procedure over the radical nephrectomy as the latter poses risk of renal and cardiovascular morbidity and mortality.[3] In the procedure of laparoscopic partial nephrectomy (LPN), only specific branch of renal artery, and tributary of renal vein are ligated in the renal hilum. This requires adequate skill of the surgeon as the structures are crowded in the renal hilum.[4] The precise knowledge of arrangement of hilar structures is also important while performing endopyelotomies.[5] There is

very limited data on the variations in the arrangement of renal hilar structures.

Objectives

Objectives of the present study were to evaluate the hilar anatomy in detail and classify the different sequences in which hilar structures were arranged.

METHODS

The present descriptive study was conducted in the department of anatomy, Vardhman Mahavir medical college, New Delhi on 64 kidneys (33 right and 31 left) derived from embalmed human cadavers. The kidneys of all ages and both sex were included in the study. Those kidneys that showed signs of trauma or any pathology were excluded from the study. This study was carried in the period from August 2019 to July 2021.

Procedure

The hilum of the kidney was dissected carefully. The fat was removed and the vessels and pelvis were cleared. The main trunk of the renal artery and vein were cut to obtain a better view of different branches and tributaries in relation to the pelvis. The kidneys were then photographed from their medial aspect to show directly the structures entering or leaving the hilum. The anteroposterior sequence of the structures was noted. The kidneys were classified into six patterns based on the arrangement of structures from anterior to posterior direction. The pattern that each kidney displayed was entered in a table and the percentage of each pattern was calculated using SPSS version 20.

RESULTS

The arrangement of structures in the renal hilum showed six different patterns in the present study. The classical pattern, with renal vein, artery and pelvis from anterior to posterior was observed in 37.5% cases (24 kidneys) (Figure 1). Remaining 62.5% cases (40 kidneys) exhibited variations, of which the pattern 2 (V-A1-P-A2) was seen in maximum cases (26.5%) (Figure 2). The pattern 3 (V1-A1-P-V2-A2) was also seen in significant number of cases (18.75%) (Figure 3). The other variant patterns were less common, each seen in less than 10% cases (Figures 4-6). The renal vein or its tributary was the anterior most structure in 89.1% cases (patterns 1, 2, 3 and 5). The branch of renal artery was the anterior most structure in the remaining 10.9% cases. The different patterns of arrangement with the percentages in which they were found are shown in (Table 1).

DISCUSSION

Knowledge of arrangement of structures in the renal hilum has assumed more importance with the advent of laparoscopic urological surgeries. The branches of renal artery, the tributaries of renal vein and the renal pelvis, are all placed together in the narrow spaced hilum.

Table 1: Six different patterns of arrangement of hilar structures.

Pattern	Arrangement of structures from anterior to posterior	Right side	Left side	Total	%
1	**V-A-P**	17	7	24	37.5
2	**V-A_1-P-A_2**	6	11	17	26.5
3	**V_1-A_1-P-V_2-A_2**	5	7	12	18.75
4	**A_1-V_1-P-A_2-V_2**	2	3	5	7.8
5	**V_1-A_1-P-A_2-V_2**	2	2	4	6.25
6	**A_1-V_1-A_2-P-A_3**	1	1	2	3.1

Table 2: Comparison of findings of present study with previous studies.

Pattern	Kumar et al.[6] (%)	Trivedi S et al.[7] (%)	Divya C et al.[8] (%)	Present study (%)
V-A-P	45.8	19	32	37.5
V-A_1-P-A_2	8.3	20	-	26.5
V_1-A_1-P-V_2-A_2	2.1	22	2	18.75
A_1-V_1-P-A_2-V_2	-	-	9	7.8
V_1-A_1-P-A_2-V_2	-	-	-	6.25
A_1-V_1-A_2-P-A_3	-	-	-	3.1

The knowledge of their arrangement and relationship with each other is of paramount importance before performing any renal surgery. In the present study, six different patterns were recognized in which the structures arranged themselves in the renal hilum from anterior to posterior direction. The classical pattern of arrangement, with renal vein, artery and pelvis from anterior to posterior, was encountered in 37.5% (24) cases only. In

the remaining 62.5% cases, the renal artery and/or renal vein showed divisions at the hilum. The findings of the present study are compared with the findings of other studies in (Table 2). The present study encountered variant patterns, predominantly on the left side. Other authors reported similar finding.[6-8] This observation may have an embryological basis.

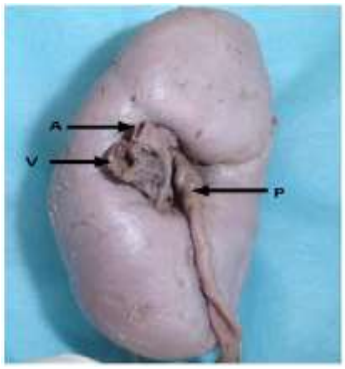

Figure 1: Right kidney showing pattern 1 (V-A-P), V-renal vein, A-renal artery, P-renal pelvis.

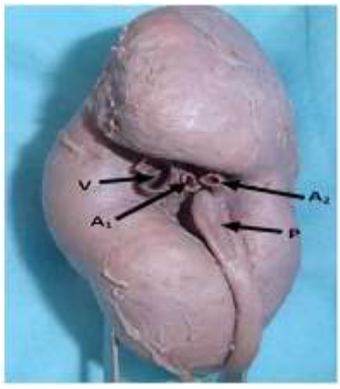

Figure 2: Right kidney showing pattern 2(V-A1-P-A2), V-renal vein, A1, A2- ranches of renal artery, P-renal pelvis.

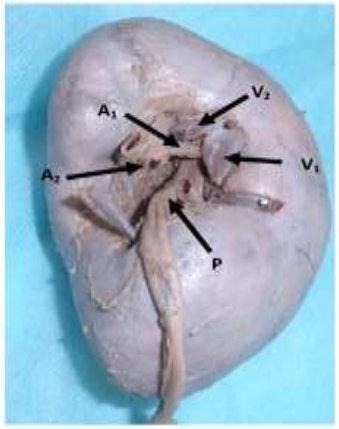

Figure 3: Left kidney showing pattern 3(V1-A1-P-V2-A2), V1, V2- ributaries of renal vein, A1, A2-branches of renal artery, P-renal pelvis.

The left renal vein is derived from anastomosis between two subcardinal veins. On the other hand, the right renal vein is derived from mesonephric vein only.[9] Because left renal vein is derived from multiple anastomotic channels, it may show greater variations and thus altered relationship with other hilar structures.

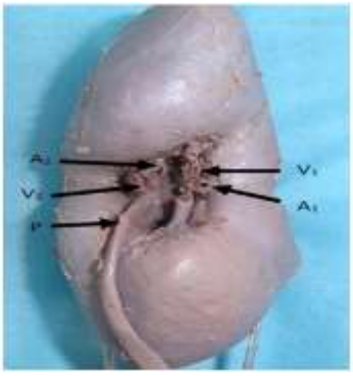

Figure 4: Left kidney showing pattern 4 (A1-V1-P-A2-V2), V1, V2-tributaries of renal vein, A1, A2-branches of renal artery, P-renal pelvis.

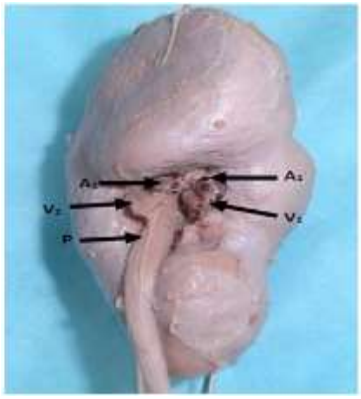

Figure 5: Left kidney showing pattern 5 (V1-A1-P-A2-V2), V1, V2-tributaries of renal vein, A1, A2-branches of renal artery, P-renal pelvis.

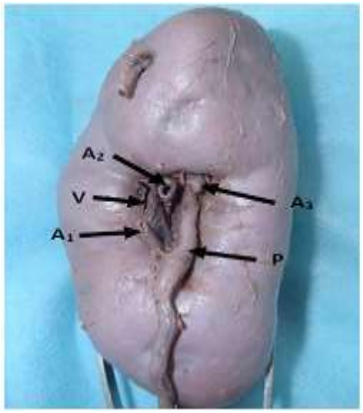

Figure 6: Right kidney showing pattern 6(A1-V-A2-P-A3), V-renal vein, A1, A2, A3-branches of renal artery, P-renal pelvis.

Due to advancements in imaging techniques, nephron sparing surgeries like laparoscopic partial nephrectomy have become more common. Thus, detailed knowledge of hilar anatomy has become all the more important.[10,11] According to Rapp et al, separate clamping of artery, vein and pelvis is preferred over en bloc clamping. This is due to the fact that en bloc clamping leads to formation of arteriovenous fistula as a late complication.[12] Sampaio et al studied the anatomic relationship of renal vessels to the renal pelvis at the hilum. They concluded that the renal pelvis is not related to the main trunk of renal vessels, but is in close proximity to the branches of renal artery and tributaries of renal vein.[13-15] Therefore, many structures are crowded in the narrow hilum. This may pose difficulty to the surgeon while dissecting and clamping individual hilar structures. Also, there are more chances of iatrogenic trauma to these structures, especially in laparoscopic procedures like laparoscopic partial nephrectomy.[4,12] The anomalous branching of renal vessels can cause ureteropelvic junction obstruction.[16,17] This pathology is associated with rotational defects of kidney.[18] The knowledge of branching pattern of renal artery and its relationship to renal pelvis is also essential while interpreting renal angiograms. The present study has certain limitations. The frequencies of different patterns were not calculated based on age and sex. Also, the side comparison was not made. Furthermore, radiological correlation of arrangement of hilar structures can add to the existing knowledge.

CONCLUSION

The classical pattern described in anatomical textbooks is not the only pattern of arrangement of renal hilar structures. Instead, variant patterns are commonly encountered. Thus, knowledge of hilar anatomy is important for surgeons so that they are careful while clamping hilar structures during renal surgery and prevent iatrogenic trauma. This knowledge is also required by radiologists to correctly interpret renal angiograms and other radiological scans. The present study attempts to elucidate the variant anatomy of the renal hilar region to help radiologists and surgeons in proper diagnosis and treatment.

Funding: Indian council of medical research
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Dawani P, Mehta V, Kaur A. Anatomical study on variable disposition of structures in the renal hilum. Int J Res Med Sci 2021;9:3039-42.