

## The Study of Pelvicaliceal System in Adult Human Kidney

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### Abstract

*Pelvicaliceal system consists of renal pelvis along with major and minor calices. There are considerable variations in the arrangement of the infundibula and renal pelvis. The present study was undertaken to find out the pattern of pelvicaliceal system of adult human kidney and pelvis. Material included 100 adult cadaveric human kidney of known sex. Observation and result : Pelvicaliceal System was classified upon the number of major calices into Tricaliceal, Bicaliceal or Y shaped, Multicaliceal or radiate, and others' category.*

**Keywords:** Major calices, Minor calices, Pelvicaliceal system

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### Introduction

Pelvicaliceal system consists of renal pelvis along with major and minor calyses. The renal capsule covers the external surface of kidney and continues through the hilum to line the sinus and fuse with adventitial coverings of minor calyces. Each minor calyx surrounds either a single papilla or rarely group of 2-3 papillas. The minor calyces unite with their neighbours to form 2 or 3 large chambers, the major calyces. There is wide variation in the arrangement of the calyces. The calyces drain into infundibula .The renal pelvis is normally formed from the junction of two infundibula - one from the upper and one from the lower pole calyces , but there may be third also, which drain the calyces in the mid portion of the kidney .The calyces are usually grouped so that the three pairs drain into the upperpole infundibula and four pairs in to lower pole infundibula . If there is middle infundibula, the distribution is normally three pairs at upper pole, two in the middle and two at the lower pole. <sup>(1)</sup>

There is considerable variation in the arrangement of the infundibula and in the extent to which the pelvis is intrarenal or extrarenal. The funnel shaped renal pelvis tapers as it

passes inferomedially, traversing the renal hilum to become continuous with the ureter. It is rarely possible to determine precisely where the renal pelvis ceases and ureter begins <sup>(2)</sup>. Hence the present study was undertaken with the intentions to study the pattern of pelvicaliceal system of adult human kidney, to study the number of major calyces and their divisions into minor calyces, to find out intrarenal and extrarenal pelvis and to study variations in both the kidneys of same individual.

### Materials and Methods

The cross sectional study consisted of 100 adult human kidneys of known sex. Kidneys were examined from the pre-embalmed cadavers in the department of anatomy of NKP Salve Institute of Medical Sciences and RC after obtaining permission from ethics committee of the institute. Gross adult pre-embalmed cadaveric kidneys with congenital anomalies were excluded. The kidneys were meticulously dissected out from the cadavers in dissection hall. They were removed with ureter and washed in running water. Size, shape and position of hilum were studied. The kidneys were cut in coronal section. Pelvicaliceal system was traced as high as possible. Then kidneys

were photographed. Kidneys were again preserved in 10% formalin.

## Results

Out of 100 kidneys examined 84 were from male cadavers and 16 were female cadaveric kidneys. On coronal section depending upon the number of major calices the Pelvicaliceal System was classified as:

- (1) Tricaliceal or triangular
- (2) Bicaliceal or Y shaped
- (3) Multicaliceal or radiate
- (4) "Others" category

### Tricaliceal or Triangular

This constituted the larger group. 54 were placed in this category. Pelvis was moderate in size. The mid pelvis diameter (mean transverse diameter) was 1.4cms. There were three major calices –upper, middle and lower. They are formed by union of minor calices draining into it. This was the commonest type of renal pelvis. In 38 cases upper calyx was dividing into 3, middle calyx was into 2 and lower calyx into 3. In 10 cases upper calyxes divided into 3 and middle into 2 and lower into 4. In 6 cases it was 3, 2, 2 in upper, middle and lower. The major calices were of same size. Positions of major calices were variable. Position of major calices was near the upper pole in 39 cases and near the lower pole in 15 cases. In 3 cases long thin infundibula was present in upper major calyx. The arrangement of minor calyx was simple i.e minor calices open into single major calyx which then joined the pelvis. Crossed mid zone minor caliceal drainage was not seen. Number of minor calices ranges from 7-9 in this pattern (Table- 1, Figure- 1).

**Table- 1: Observed kidney pattern (n=100)**

Pattern observed	No.
Tricaliceal	54
Bicaliceal	30
Multicaliceal or radiate	12
Others	04

### Y shaped Pelvis or Bicaliceal

30 kidneys were placed in this category. Pelvises were very small with long infundibula. Mid pelvis diameter (mean transverse diameter) was 1.1 cms (1-1.2cms). Pelvis was formed by the union of two major calices-upper and lower. Middle calyx was not present. Arrangement of

major calices was like that of letter Y. There were different types in this category like Classic Y shape or symmetrical where the two stem (calyx) were receiving 4-5 minor calices from the upper and lower zone. 25 kidneys were placed in this category. Another type was, Asymmetrical type in which one of the two infundibuli was much longer and more dominant. 5 cases were placed in this category. Number of minor calices in upper major and lower major calyx was 4 each in 24 cases. In 6 cases it was 4 in upper major calyx and 5 in lower major calyx (Figure- 2).

**Figure- 1: Tricaliceal Kidney**



### Multicaliceal or Radiate

12 kidneys are placed in this category. Pelvis was largest in this category. Mid pelvis diameter (mid transverse diameter) was 1.6 cms (1.5-1.7cms). In this category there were upper and lower major calices, three or four minor calices drain directly into pelvis. Infundibulum were short. Size of upper and lower calyx was same but the middle one were of smaller size (Fig. 3).

**Figure- 3: Multicaliceal Kidney**



### Others

In this category included those kidneys which cannot be classified under above three categories. It included 4 kidneys in which size of pelvis was equal to the ureter.

Out of 100 kidneys examined from 50 cadavers, 46 showed the same pattern on both side i.e

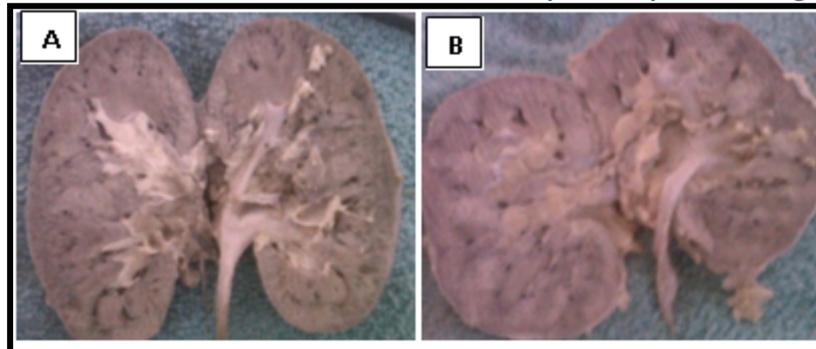
right and left whereas 4 male cadavers showed dissimilar pattern on right and left side i.e there was tricaliceal pattern on right kidney and Bicaliceal type on left side in all four cadavers. No such dissimilar pattern was seen in female cadavers. Out of 100 kidneys dissected 84 were from male cadavers and 16 were from female cadavers. In kidneys from female cadavers tricaliceal kidneys were 8 (4 on right side and 4

on left side), bicaliceal kidneys were 6 (3 right and 3 left), Multicaliceal kidneys were 2 (1 right and 1 left). Pelvis is intrarenal where it lies entirely within the renal sinus or extrarenal where it lies like a dilated sac largely outside the kidney proper. Out of 100 kidneys examined 98 had intrarenal pelvis and only two had extrarenal pelvis (Table- 2, Figure- 4).

**Figure- 2: Y- Shaped (Bicaliceal Kidney)**



**Figure- 4A & B: Extrarenal Pelvis, Pelvis of Kidney directly continuing as ureter**



**Table- 2: Gender differences in the pattern (female-16, male- 84)**

Pattern	Male		Female	
	Right kidney	Left kidney	Right kidney	Left kidney
Tricaliceal	25	21	4	4
Bicaliceal	10	14	3	3
Multicaliceal	5	5	1	1
Others	2	2	0	0

## Discussion

Pelvicaliceal system in humans has been studied by various means. Initially it was studied by dissection on cadavers later on by intravenous pyelography and now newer techniques like CT scan, Three Dimensional visualisation are done. We studied Pelvicaliceal system by dissection method as it is the most accurate one. In present

study depending upon the major calices / infundibula, Pelvicaliceal system has been classified as tricaliceal or triangular, Bicaliceal or Y shaped, Multicaliceal or radiate and others. We found that the Tricaliceal or triangular are present in 54%, Bicaliceal or Y shaped in 30%, Multicaliceal or radiate in 12% and 4% of kidneys showed size of pelvis equal to the size of ureter. These findings are in accordance with

the findings of Ningthoujam DD, Choungtham RD, Sinam SS (2005)<sup>(3)</sup>, Fine and Keen (1966)<sup>4</sup> and Graves (1986)<sup>(5)</sup> and also with Sampaio and Mandarin-De-Lacerda (1988)<sup>(6)</sup>. Graves (1986) classified pelvicaliceal arrangement into two primary and two intermediate type based on the shape of pelvis and also on the prominence of calyces. Graves classified them as Type A is the classic Y type, Type B as the inverted T, type C as the balloon and type D as inverted bagpipes. Sampaio and Mandarin described pelvicaliceal system into four types according to drainage pattern of polar region and mid (mid-hilar) zone. The types A I and A II presented 2 major caliceal groups. The type B I and B II presented mid zone drainage independent of superior and inferior caliceal group.

Our study states that usually major calices are three in number (superior, middle and inferior calices) but the number of minor calices draining into the upper and lower calices range from 3-5 in number whereas that of middle calyx is limited to 2-4 from the anterior and posterior aspects but in some cases the pelvis has only the upper and lower calyces and in such cases mid zone drainage is done by the minor calices in close proximity which joins the neighbouring major calices. In four renal units (2%) studied, pelvis could not be demonstrated since the ureter directly bifurcated into calices as has been reported by Bruce et al (1967)<sup>(7)</sup> and Kabalin (1992)<sup>(8)</sup>. The present study has already highlighted the occurrence of Y shaped pelvis where there is hardly any room and calibre of each stem of Y is almost same as that of the upper ureter.

Our study recorded 2 extrarenal pelvis and 98 intrarenal pelvis in dissected kidneys. Extrarenal pelvis was roomier than intrarenal pelvis. Similar findings are also given by Bruce et al (1967)<sup>(7)</sup>, Anson and Macvay (1971)<sup>(8)</sup>, Edwards et al (1975)<sup>(9)</sup>, Isadore Meschan (1976)<sup>(10)</sup>, Sykes and David (1964)<sup>(11)</sup>.

Sykes and David (1964)<sup>(11)</sup> studied the extrarenal portion of the renal pelvis in 240 kidneys and twelve of these possessed extrarenal major calyces (5%).

In present study we found that major calyces were dividing into minor calyces which vary in number between 6-12. These findings are correlated with the findings of Sykes and David (1964)<sup>(11)</sup>, Fine and Keen (1966)<sup>(4)</sup>, Hallinshead

(1975)<sup>(12)</sup>, Harrison (1972)<sup>(13)</sup>, Ningthoujam DD, Choungtham RD, Sinam SS (2005)<sup>(3)</sup>. The arrangement of minor calices was simple i.e minor calices open into single major calyx which then joined the pelvis. Similar findings are described by Sabnis RB et al (1997)<sup>(14)</sup>.

We found in 46 cadavers, same pattern on both sided i.e right and left whereas 4 male cadavers showed dissimilar pattern on right and left side i.e there was tricaliceal type of pattern on right kidney and bicaliceal type on left side in all four cadavers. According to Sampaio and Mandarin –De –Lacerda (1988)<sup>(6)</sup> the kidney collecting system is amply varied and showed morphologic bilateral symmetry in only 37% of the casts (26 pairs of casts).

The knowledge of such wide ranging pattern of pelvicaliceal system and in particular the presence of anterior and posterior minor calices, the angles they make with pelvis, the direction of minor calices and cross drainage is must for surgeons and interventional radiologists. And this study will definitely help them in planning and executing their procedures more accurately.

## Conclusion

There are wide ranging pattern of pelvicaliceal system and can be classified into Tricaliceal or triangular 54%, Bicaliceal or Y shaped 30% , Multicaliceal or radiate 12% and others 4% of kidneys. Usually major calices are three in number viz superior, middle and inferior calices but the number of minor calices draining into the upper and lower calices range from 3-5 in number whereas that of middle calyx is limited to 2-4 from the anterior and posterior aspects. There are two type of pelvis –extrarenal and intrarenal. Extrarenal pelvises are roomier than intrarenal pelvis. The pattern of pelvicaliceal system is not always same on both sides. The pattern shows dissimilarity.

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