

# Comparative study of Pelvi-calyceal system and relationship of structures at hilum of kidney between Nepalese and North Americans

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## ABSTRACT

**Introduction:** Pelvi-calyceal system consists of renal pelvis along with major and minor calyces. The minor calyces unite with their neighbors two or three chambers to form the major calyces. The major calyces drain into the infundibula. The renal pelvis is formed from the junction of the infundibula.

The common pattern of arrangement of structures at the renal hilum, antero-posteriorly is renal vein, renal artery and pelvis.

**Objectives:** To compare the study of pelvi-calyceal system and relationship of structures at hilum of kidney between Nepalese and North Americans.

**Methodology:** The gross and prosected kidney specimens were studied for pelvi-calyceal system and relationship of structures at hilum of kidney in Anatomy department. In Nepal, the study was undertaken in Gandaki Medical College, Kaski and in USA, it was done in Well-cornell University, New York.

**Result:** Tricalyceal major calyx were found in 63.8% in Nepalese and Bicalyceal were found in 65.6% North Americans which is statistically significant variations. The number of minor calyces and pyramids varying 6 in Nepalese and 9 in North Americans were also statistically significant ( $p < 0.05$ ). The arrangement of structures at hilum of kidney from anterior to posterior (renal vein, artery and pelvis) in Nepalese and North American kidneys was 86.1% and 62.5% respectively whereas the structures arranged as renal artery, vein and pelvis from anterior to posterior was 13.9% and 37.5%.

**Conclusion:** There is significant variations in pelvicalyceal system and relations of structures at hilum of kidneys of Nepalese and North-Americans.

## Keywords

*pelvicalyceal, structures and hilum of Kidney*

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## INTRODUCTION

Pelvi-calyceal system consists of renal pelvis along with major and minor calyces.<sup>1,2</sup> On coronal section, the

kidney has an outer cortex and an inner medulla. The cortex extends centrally as the columns and separate the medulla into pyramids. The apical portion of the pyramids

protruding into the minor calyces is known as papilla.<sup>3,4</sup> The minor calyces unite with their neighbors two or three chambers to form the major calyces. The major calyces drain into the infundibula.<sup>4,5</sup> The renal pelvis is formed from the junction of the infundibula. The minor calyces, the major calyces, the infundibula, and the renal pelvis are collectively known as intrarenal collecting system.<sup>6</sup> Variations in the gross anatomy of the renal collecting system are probably as numerous as that of individual's fingerprints.<sup>7</sup>

The Kidney is a retroperitoneal organ which is supplied by single renal artery and drained by single vein.<sup>8,9</sup> The renal artery arises laterally from the aorta just below the origin of the superior mesenteric artery. The right renal artery (RRA) is longer and often higher, passing behind the inferior vena cava (IVC) and right renal vein. The left renal artery is a little lower and passes posterior to the left renal vein. In 70% of individuals, a single renal artery to each kidney is present. Accessory renal arteries are common in 30% of individuals, and usually branch from the aorta above or below (most commonly below) the main renal artery and follow it to the renal hilum.<sup>10,11</sup> Accessory renal arteries may also enter the kidneys directly, usually into the upper or lower poles. Accessory renal artery to the lower pole (polar renal artery) may cross anterior to the ureter and obstruct it, causing hydronephrosis. If the artery enters to the lower pole of the right kidney, it usually crosses anterior to the IVC and ureter. They are considered as persistent embryonic lateral splanchnic arteries. It is important to be aware that accessory renal arteries are end arteries; consequently if an accessory renal artery is damaged or ligated, the part of the kidney supplied by it is likely to become ischemic. Accessory renal arteries are about twice as common as accessory veins.<sup>12</sup>

The large renal veins lie in front of the renal arteries and open into the inferior vena cava almost at right angles. The left renal vein is three times of the right vein in length (7.5 cm and 2.5 cm). The left renal vein may be double, one vein passing posterior, the other anterior to the aorta before joining the inferior vena cava. The right renal vein is posterior to the descending part of duodenum.<sup>13</sup>

In the standard anatomical texts, the arrangement of structures at the renal hilum, antero-posteriorly as described is: renal vein, renal artery and pelvis.

#### **Rationale of study:**

Since there is variation in arrangement of structure

present at hilum of kidney and pelvi-calyceal system, the present study was performed to compare pelvi-calyceal system and relation of structures present at hilum of kidney between Nepalese and North Americans.

#### **Importance of Study:**

The present study will be useful for uro-surgeons while doing surgery of kidney even for transplant surgery of kidney; for radiologists while carrying out pyelography; for anatomists to study variations of structures at hilum and within the kidney.

#### **OBJECTIVES**

- I. To compare the study of pelvi-calyceal system between Nepalese and North Americans.
- II. To compare the study of relationship of structures at hilum of kidney between Nepalese and North Americans.

#### **Methodology**

The prosected kidney specimens were studied in Anatomy department. In Nepal, the study was undertaken in Gandaki Medical College, Kaski from December 2013 to December 2018 and in USA, it was done in Well-cornel University, New York from May 2016 to April 2019.

#### **Ethical consideration**

There were no ethical issues in present research because research was carried out on dead prosected specimens of kidneys. Ethical approval was obtained from institutional ethical committee of concerned institute.

#### **Sampling method, sample size and study procedure**

Convenience sampling method was adopted. All available kidneys during study period in Anatomy department of Gandaki Medical College and well-cornel University, New York were studied.

For study of renal pelvi-calyceal system: 36 kidneys (18 left and 18 right sided) were studied in Nepal and 32 kidneys (16 left and 16 right sided) were studied in US. The kidneys were dissected coronally and number of major calyces, minor calyces and pyramids were counted and noted down.

For the study of the relationship of structures at hilum of

kidney, Gross, prosected kidney specimens of 36 kidneys (18 left and 18 right sided) were studied in Nepal where as 24 (12L, 12R) in US. The renal vein, artery and pelvis were observed in hilum and their antero-posterior relations were noted down.

**Reliability and validity of research**

To ensure good reliability and validity of research inter-observer bias was eliminated There was 95% observed agreement(Cohen’s kappa value 0.95)

**Statistical analysis**

Data were entered in excel sheet and analysis were performed using SPSS 16.0. Percentage was calculated . The chi-square test was applied to test the significant difference of variations between Nepalese and North American kidneys. A 95% confidence interval was set to observe the difference(p value <0.05 as significant).

**RESULT**

Coronally dissected 36 kidneys (18 left and 18 right sided) were studied in Nepal and 32 kidneys (16 left and 16 right sided) were studied in United States.

Pattern of major calyces were studied and their number was noted down. The statistical result in terms of percentage has been presented in table 1 below:

**Table1:** Distribution of major calyces in Nepalese and North American kidneys

S.N	Major calyces types	In Nepalese kidney(n=36)	In North American kidney(n=32)	Pvalue
	Monocalyceal	0%(n=0)	0%(n=0)	0.0
	Bicalyceal	33.3%(n=12)	65.6%(n=21)	0.02*
	Tricalyceal	63.8%(n=23)	31.2%(n=10)	0.02*
	Quadricalyceal	2.8%(n=1)	3.1%(n=1)	0.06

\* statistically significant.

In Nepalese kidney, 63.8% were tricalyceal followed by 33.3%, 2.8% and 0% bicalyceal, quadricalyceal and monocalyceal respectively. Similarly, 65.6%, 31.2%, 3.1% and 0% were bicalyceal, tricalyceal, quadricalyceal and monocalyceal in North American kidneys respectively. The bicalyceal and tricalyceal pattern showed significant difference between Nepalese and North American kidneys.

Number of minor calyces were counted and noted down. The statistical result in terms of percentage has been presented in table 2 below:

**Table 2:** Distribution of minor calyces in Nepalese and North American kidneys

S.N	No. of minor calyces	In Nepalese kidney(n=36)	In North American kidney(n=32)	P value
	4	11.1%(n=4)	0%(n=0)	0.06
	5	22.2%(n=8)	0%(n=0)	0.05
	6	61.1%(n=22)	0%(n=0)	0.01*
	7	2.8%(n=1)	9.3%(n=3)	0.07
	8	2.8%(n=1)	25%(n=8)	0.05
	9	0%(n=0)	46.8%(n=15)	0.03*
	10	0%(n=0)	12.5%(n=4)	0.05
	11	0%(n=0)	6.25%(n=2)	0.08

\* statistically significant.

In 61.1%, 22.2%, 11.1%, 2.8%, 2.8% Nepalese kidney, number of minor calyces were found to be 6,5,4,7 and 8 respectively and in 46.8%, 25%, 12.5%, 9.3% and 6.25% North American kidneys, number of minor calyces were found to be 9,8,10,7 and 11 respectively.

The distribution of only six and nine numbers of minor calyces showed significant difference between Nepalese and North American kidneys.

Number of pyramids were counted and noted down. The statistical result in terms of percentage has been presented in table 3 below:

**Table3:** Distribution of pyramids in Nepalese and North American kidneys

S.N	No. pyramids	In Nepalese kidney(n=36)	In North American kidney(n=32)	P value
	4	11.1%(n=4)	0%(n=0)	0.06
	5	22.2%(n=8)	0%(n=0)	0.05
	6	61.1%(n=22)	0%(n=0)	0.01*
	7	2.8%(n=1)	9.3%(n=3)	0.07
	8	2.8%(n=1)	25%(n=8)	0.05
	9	0%(n=0)	46.8%(n=15)	0.03*
	10	0%(n=0)	12.5%(n=4)	0.05
	11	0%(n=0)	6.25%(n=2)	0.08

\* statistically significant.

In 61.1%, 22.2%,11.1%, 2.8% and 2.8% Nepalese kidneys, number of pyramids was found to be 6,5,4,7 and 8. Similarly, in 46.8%, 25%, 12.5%, 9.3%, 6.25% North American kidneys, number of pyramids was found to be 9,8,10,7 and 11 and respectively.

The distribution of only six and nine numbers of pyramids showed significant difference between Nepalese and North American kidneys.

The antero-posterior relations of structures at hilum of kidney were studied and pattern of relationship were noted down. The statistical result in terms of percentage has been presented in table 4 below:

**Table 4:** Showing the comparison of relation of structures at hilum of kidney between Nepalese and North Americans

S.N	Relation of structures at hilum (from anterior to posterior)	In Nepalese kidney(n=36)	In North American kidney(n=32)	P value
	Renal vein, artery and pelvis	86.1%(n=31)	62.5%(n=20)	0.05
	Renal artery, vein and pelvis	13.9%( n=5)	37.5% (n=12)	0.05

In 86.1% Nepalese kidney and in 62.5% North American kidneys, relation of structures at hilum (from anterior to posterior) Renal vein, artery and pelvis was respectively and in 13.9% Nepalese kidney and in 37.5% North American kidneys, relation of structures at hilum (from anterior to posterior) Renal artery, vein and pelvis was respectively.

## DISCUSSION

Renal minor calyces are cup shaped structures which are present at the apices of the pyramids. There are minor calyces and major calyces. Many papillary ducts open at the apex of the pyramid which is formed by the union of many collecting ducts. The minor calyces are the cup like dilatations seen at the apex of one or more pyramids. Therefore, the number of minor calyces do not correspond the number of pyramids. Minor calyces join to form 2 to 3 major calyces.<sup>14</sup>

In the standard anatomical texts, the arrangement of structures at the renal hilum, antero-posteriorly as described is: renal vein, renal artery and pelvis. In some cases, posterior division of renal artery and posterior tributary of renal vein might be seen entering posterior to pelvis.<sup>15</sup> The present study aimed to compare pelvicalyceal system and structures present at hilum of kidney between Nepalese and North Americans.

In present study, the number of minor calyces varies from

4 to 11 and most often 6 minor calyces were present in Nepalese kidney and 9 minor calyces were present in North American kidney. Wadekar<sup>16</sup> reported that the numbers of minor calyces were 5 to 11 (most often 8). Supriya et al.<sup>17</sup> found that in right kidney, number of minor calyces varies from 2 to 10 and average of 6 and from 3-9 in left kidney with average of 6. Similarly, Ningthoujam et al<sup>18</sup> stated that the numbers of minor calyces were 6 to 12 and 9 were most often reported.

Wadekar et al.<sup>16</sup> reported the number of major calyces varies from 2 to 3 and two major calyces were present in 60%. Similarly, in the present study, the number of major calyces ranges from 2 to 4. In Nepalese kidney, 3 major calyces were found in 63.8% and 2 major calyces were found in 65.6% North American kidney. Major calyces varying from 1 to 5 in right and left kidney were reported on a study by Supriya et al.<sup>17</sup>

In our present study, 4 to 11 numbers of pyramids were reported and in 61.1% Nepalese kidney, the number of pyramids were 6 and 9 pyramids were noted in 46.8% North American kidney. The study conducted by Supriya et al.<sup>17</sup> mentioned that number of pyramids varies from 6 to 18 and 6 to 13 with average of 10 and 9 in right and left kidney respectively.

In the present study, relation of structures at hilum of kidney from anterior to posterior was renal vein, artery and pelvis in 86.1% and 62.5%, Nepalese and North American kidneys respectively. And in 13.9% Nepalese kidney and 37.5% North American kidney, the relation of structure was renal artery, vein and pelvis from anterior to posterior. Trivedi et al<sup>15</sup> found that in majority (73%), the arrangement was not according to common pattern of arrangement i.e. renal vein, renal artery and pelvis arranged antero-posteriorly. In 31% anterior division of renal artery was seen in front of renal vein at the hilum, whereas, in 50% cases the pelvis was not the posterior most relation. Supriya et al.<sup>17</sup> reported common pattern of hilar arrangement in 66% and 70% in right and left kidney where as 34% and 30% cases showed variation pattern in right and left kidneys respectively. Sinha et al<sup>19</sup> found that in majority, the arrangement was according common pattern of arrangement i.e. renal vein, renal artery and renal pelvis arranged antero-posteriorly. In 5% of cases renal artery was seen in front of renal vein and renal pelvis at the hilum.

The present study has useful implications. While doing surgeries of kidneys like nephrectomy, transplant

surgeries of kidney the relationship of structures at hilum and their variations should be well known to urosurgeons otherwise urosurgeons will face lots of problems during operation. The radiologists should be aware of calyceal system of kidneys and their variations while carrying out pyelography otherwise radiologists may encounter problems while interpreting pyelogram. Anatomists also should be well aware of the relationship of structures at hilum and their variations and calyceal system of kidneys and their variations while teaching medical students.

### Limitations of study

This study is a small contribution with small sample size of kidneys, however what were available were studied. The similar studies should be done in other parts of world and metaanalysis should be carried out in future.

### CONCLUSION

The distribution of major calyces showed significant difference ( $p < 0.05$ ) between Nepalese and North American kidneys. In Nepalese kidney, 3 major calyces (Tricalyceal) were found in 63.8% and 2 major calyces (Bicalyceal) were found in 65.6% North American kidney. The number of minor calyces and pyramids varying 6 and 9 were also statistically significant ( $p < 0.05$ ) between Nepalese and North American kidneys respectively. The arrangement of structures at hilum of kidney from anterior to posterior (renal vein, artery and pelvis) in Nepalese and North American kidneys was 86.1% and 62.5% respectively whereas the structures arranged as renal artery, vein and pelvis from anterior to posterior was 13.9% and 37.5% in Nepalese and North American kidneys respectively.

**Conflict of interest:** none

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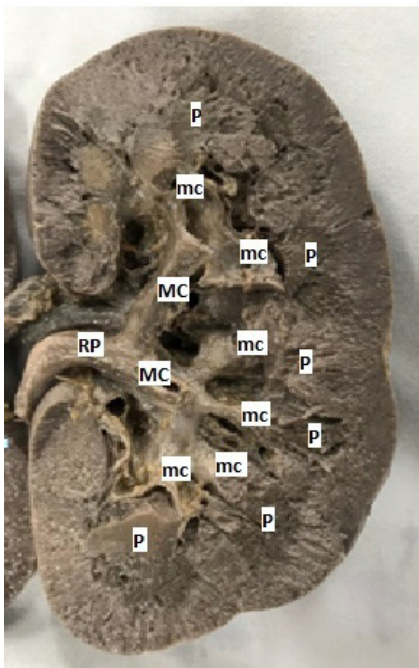
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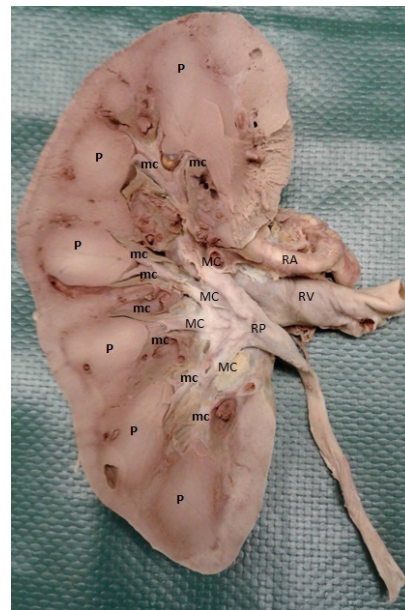
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LEGENDS:



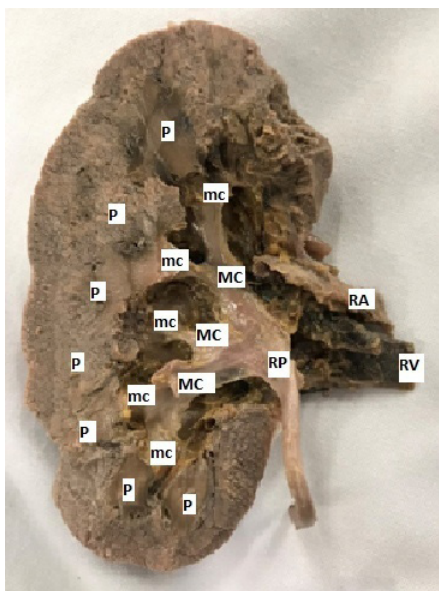
**Figure 1:** The coronal section of kidney showing bicalyceal pattern of pelvi-calyceal system.

P- pyramid, mc- minor calyx, MC- major calyx, RP- renal pelvis.



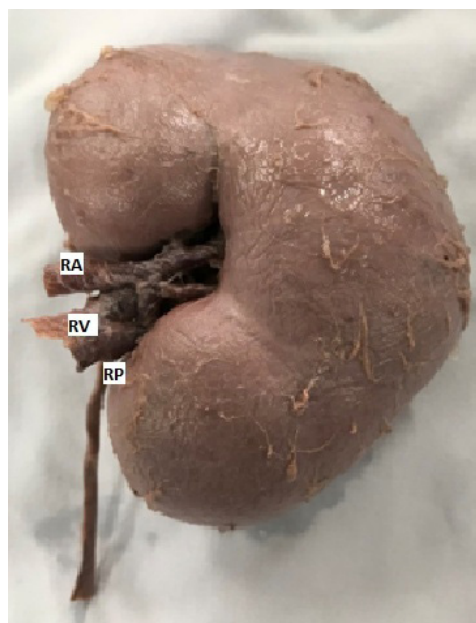
**Figure 3:** The coronal section of kidney showing quadricalyceal pattern of pelvi-calyceal system.

P- pyramid, mc- minor calyx, MC- major calyx, RP- renal pelvis, RA- renal artery, RV- renal vein.



**Figure 2:** The coronal section of kidney showing tricalyceal pattern of pelvi-calyceal system.

P- pyramid, mc- minor calyx, MC- major calyx, RP- renal pelvis, RA- renal artery, RV- renal vein.



**Figure 4:** Anterior surface of kidney showing the relations of structures at hilum; renal artery, renal vein and renal pelvis from anterior to posterior.

RP- renal pelvis, RA- renal artery, RV- renal vein.