

## Original Research Article

# A cadaveric study on anatomical variations of kidney and ureter in a tertiary care teaching hospital

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### Abstract

**Introduction:** The kidneys are a pair of bean - shaped organs situated in the back of the abdomen between the 12<sup>th</sup> thoracic and 3<sup>rd</sup> lumbar vertebrae. Each kidney is about 4 or 5 inches long - about the size of a fist. The main objective of this study was to study the major anatomical variations of kidney and urinary tract.

**Methods:** The study was conducted at department of Anatomy, Indira Gandhi Medical College & Hospital, Shimla-1, during routine dissections of 36 cadavers over a period of four years. All specimens included in the study were adult cadavers of which 25 were males and 11 were females.

**Observations and results:** Out of 36 cadavers, 1 cadaver showed bilateral and 4 showed unilateral (3L, 1R) lobulated kidney, 3 cadavers showed unilateral (2L, 1R) and 1 showed bilateral accessory renal artery. 3 cadavers showed unilateral (2 L, 1 R) incomplete double ureter.

**Conclusions:** 13.9% of the cadavers showed anatomical variations in kidney and 8.3% showed bifid ureter. The knowledge of anatomical variations of kidney and ureter is of utmost importance for surgical, radiological and academic purpose. Hence, an early detection may be helpful in better management and increased survival rates.

**Keywords:** Anatomical variations, Kidney, Ureter.

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### Introduction

The kidneys are a pair of bean - shaped organ situated in the back of the abdomen between the 12<sup>th</sup> thoracic and 3<sup>rd</sup> lumbar vertebrae. Each kidney is about 4 or 5 inches long - about the size of a fist. As the kidneys filter blood, they formed urine, which collects in the kidney's pelvis - funnel shaped structure that connects to the bladder through ureters. Each ureter is about 25 - 30 cm long, 3 mm in diameter, thick walled, and is continuous above with

the funnel shaped renal pelvis. The ureter travels downwards to enter the lateral angle of urinary bladder. The ureter passes obliquely through the wall of the bladder about 1.9 cm before opening into the urinary bladder.<sup>(1)</sup> Each kidney has only one ureter but there are cases where ureteral duplication can be seen that can be grouped under congenital anomalies of the kidney. Ureteral duplication may be incomplete or complete. Incomplete duplication of ureter is known as bifid ureter. Incomplete

duplication is said to be present if there are 2 separate ureters at the proximal aspect and they join at any point below uretero-pelvic junction, but before entering into the bladder whereas complete duplication is when there are two separate ureters that are continuous and enter the urinary bladder separately. Similarly, each kidney is supplied by a single renal artery that usually arises from the abdominal aorta and enters the kidney through the hilum, near the hilum the renal artery divides into anterior and posterior division. Besides the renal arteries, the kidneys receive additional blood supply from the accessory or aberrant arteries. Accessory renal arteries occur commonly in 26 - 30 % of individuals. Kidneys are the most common site of congenital abnormalities in the human body. Congenital anomalies of kidney and urinary tract contribute approximately 20 to 30% of all anomalies identified in the prenatal period.<sup>(2,3)</sup> Multiple lobulations of kidney are witnessed throughout the fetal life.<sup>(4)</sup> Most of them disappear during the first year of birth but differing degrees of lobulations may persist in the adult life. It is caused due to incomplete fusion of developing renal lobules. As adequate information is lacking regarding the study of congenital anomalies of kidney and urinary tract in Indian population, cadaveric study is significant and relevant even in the modern era of imaging

techniques. Hence, the present study was planned to assess the anatomical variations in kidney and the ureter.

**Aims & Objectives:** To study the major anatomical variations of kidney and urinary tract.

**Material & Methods:**

The present study was performed over a period of four years from 2012-2016 on 36 well preserved human cadavers in the Anatomy department of Indira Gandhi Medical College & Hospital, Shimla-1, Himachal Pradesh, India. All specimens taken in the study were adult cadavers of which 25 were males and 11 were females. Specimens showing crush and cut injuries of kidneys or ureter were excluded from the study. All the specimens were properly dissected and observed on both the right and the left sides to inspect the presence of any anatomical variations in the kidney and ureter. The dissection method used was based on the Cunningham's dissection manual.<sup>(5)</sup>

**Observations & results:**

Out of 36 cadavers 31 were normal, 3 of them showed lobulated kidney with presence of accessory renal arteries, 1 showed only lobulated kidney and 1 showed only presence of accessory renal artery, thus 5 cadavers out of the total showed variations in the kidney (Table 1 and 2). Out of 36 cadavers, 3 showed presence of unilateral bifid ureter while the rest showed normal ureter (Table 3).

**Table 1: Prevalence of variations in the kidney**

No. of cadavers	Cadavers showing normal kidney	Percentage (%)	Cadavers showing variations in kidney	Percentage (%)
36	31	86.1	5	13.9

**Table 2: Unilateral and bilateral variations of the kidney**

No. of cadavers	Cadavers showing normal kidney	Percentage (%)	Cadavers showing lobulated kidney		Percentage (%)	Cadavers showing accessory renal arteries		Percentage (%)
			U/L	B/L		U/L	B/L	
36	31	86.1	4 (3L, 1R)	1	13.9	3 (2L, 1R)	1	11.1

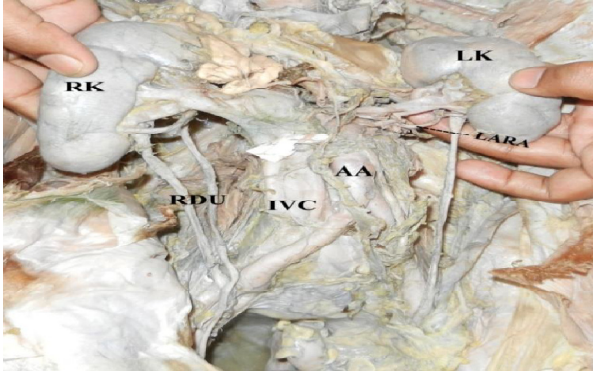
**Table 3: Unilateral and bilateral variations of the ureter**

No. of cadavers	Cadavers showing normal ureter	Percentage (%)	Cadavers showing bifid ureter		Percentage (%)
			U/L	B/L	
36	33	91.7	3(2L, 1R)	0	8.3

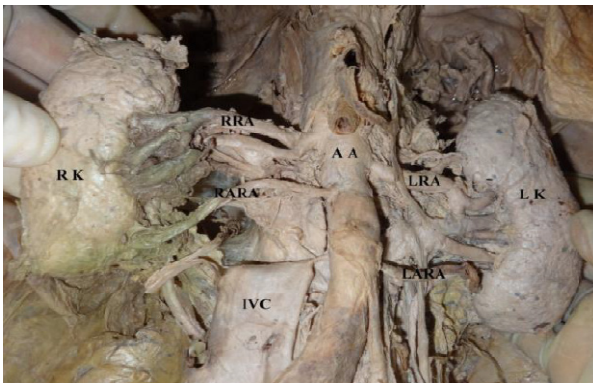
**Discussion:**

There are a multitude of congenital anomalies involving the kidney and ureter and the authors have tried to discuss few of them noted during the study. The findings of this study include presence of unilateral bifid ureter, unilateral and bilateral lobulated kidneys and unilateral and bilateral accessory renal arteries. Incomplete duplication of the ureter may be due to some fallacy or disturbance in development of uretic bud which arises from mesonephric duct. Duplication of the ureter is a consequence of early splitting of the uretic bud. Splitting may be partial or complete, and metanephric tissue may be divided into two parts, each with its own renal pelvis and ureter. One of the buds generally has a normal position, whereas the abnormal bud moves down together with the mesonephric duct. Thus, it has a lower, abnormal entrance into the bladder, urethra, vagina, or

epididymal region.<sup>(6,7)</sup> The ureters may join before reaching the bladder or remain separate while entering the bladder at two separate points. According to Lowsly et al.<sup>(8)</sup> out of 4215 cadavers studied, 18 showed duplication of ureter. Out of 18, 7 were having unilateral incomplete duplication, 2 were bilaterally incomplete and 8 presented with unilateral complete duplication. According to Russel et al.<sup>(9)</sup>, an average of 3% urethral duplication was seen. Duplex systems are the most commonly encountered congenital anomalies of the renal tract, with a reported incidence of 0.8 %.Asakawa M et al.<sup>(10)</sup> observed 5 cases of double pelvis and ureter among 340 cadavers (1.47%, 1.8% R, 0.3% L).In the present study, out of 36 cadavers, 3 cadavers showed unilateral incomplete duplication (5.53%, 3.12% R, 2.77% L) (Figure 1).



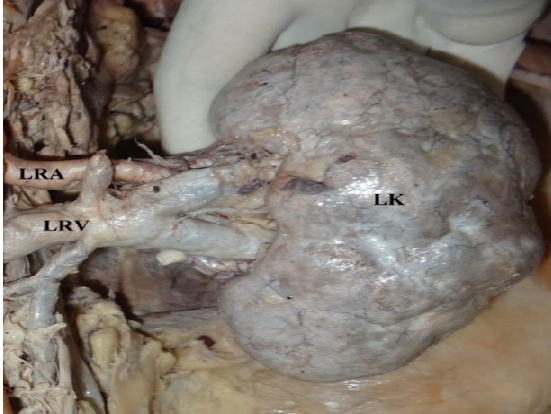
**Figure 1: Left and right kidney with unilateral right double ureter, unilateral left accessory renal artery and bilateral lobulated kidney. (LK: left kidney; RK: right kidney; IVC: inferior vena cava; AA: abdominal aorta; RDU: right double ureter; LARA: left accessory renal artery).**



**Figure 2: Left and right kidney with bilateral accessory renal artery. (LK: left kidney; RK: right kidney; AA: abdominal aorta; IVC: inferior vena cava; LRA: left renal artery; RRA: right renal artery; LARA: left accessory renal artery; RARA: right accessory renal artery).**

Embryologically, the kidney develops in several distinct lobules that fuse as they develop and grow. Incomplete fusion of these renal lobules can remain postnatally.<sup>(11)</sup> Normally these lobulated structures of the kidney are apparent at birth and gradually disappear during infancy as the nephrons increase and grow and fully disappears in first five years of life. According to Manisha et al.<sup>(12)</sup> lobulations can be

observed in 5% of right kidney and 10% of left kidney. Patil et al.<sup>(13)</sup> reported a rare congenital abnormality of the kidney where bilateral lobulation and mal-rotation were observed in association with open hilar structure of kidney. In the present study, 6.25% presented with lobulation in the left kidney and 3.12% showed bilateral lobulations (Figure 1, 3, 4).



**Figure 3: Unilateral lobulated left kidney.**



**Figure 4: Unilateral lobulated right kidney.**

The artery arising from abdominal aorta or from main renal artery is termed as accessory renal artery. It usually originates between T11 and L4 levels and its incidence ranges from 11-61%.<sup>(14)</sup> Persistent foetal renal vessels is also considered a fact for accessory renal arteries and are called polar arteries; as it enters either to the upper or the lower pole.<sup>(15,16)</sup> Accessory renal arteries whether to the upper or lower pole is always in conjunction with embryological defects. According to Tania Regina out of 24 cadavers, 6% showed accessory renal arteries. Saritha S et al.<sup>(17)</sup> reported an incidence of 8% accessory renal arteries in 25 cadavers. Vijaijanand et al.<sup>(2)</sup> have discovered that out of 29 cadavers, 2 of them showed accessory renal

arteries. Satyapal KS et al.<sup>(18)</sup> mentioned that the incidence of accessory renal arteries is higher in left kidney as compared to the right kidney. In the present study, accessory renal arteries were present in 11.1% of which 6.25% showed unilateral (5.6% L and 2.8% R) and 2.8% showed bilateral (Figure 1, 2).

**Conclusion:**

In conclusion, a number of variations could be observed in the anatomy of kidney and ureter through cadaveric dissection. A greater number of such studies should be conducted to enhance the precision of surgery in this region and limit the avoidable complications arising out of these variations.

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