



## Clinical assessment of morphometric estimation of human cadaveric kidney from Telangana state

Dr. Barun Kumar

Assistant Professor, Department of Anatomy, Prathima Institute of Medical Sciences, Nagunoor, Telangana, India

### Abstract

Morphometric studies have gained much research attention as they are believed to possess significant clinical importance. Condition like systemic diseases, urinary tract diseases, congenital anomalies, neoplasia, micro and macrovascular diseases were reported to significantly influence kidney sizes dimensions could possess significant clinical value. It is necessary to distinguish a pathological kidney from a normal sized healthy kidney. Structural arrangements or alterations at the hilum also possess medical significance, as per the available case reports. But studies related to morphometric determination of renal dimensions and hilum structures still appear limited and need to be strengthened with additional findings. Hence the present study was planned assess the morphometric evaluation and variation in renal hilar structure.

The present study was planned in Department of Anatomy, Prathima Institute of Medical Sciences, Nagunoor, Telangana from January 2007 to July 2008. The study was planned in 30 Cadaveric kidney obtained to institute. Total 30 kidney specimens were obtained out of which 15 are left kidneys and 15 are right kidney. Morphology of the kidneys was studied with the features like length, breadth, thickness, and weight. The arrangement of renal hilar structures was also observed. Approval of the institutional ethical committee was taken prior to conduct of this study.

As morphological findings help to determine anatomical variations of kidney, such studies will help to strengthen the current literature. Renal dimensions and hilar structural arrangements could possess significant clinical value. Knowledge of this variation can be utilized in various fields of medical sciences i.e Anatomist, Radiologists and Surgeons for better clinical understanding and outcome.

**Keywords:** kidney, morphometric, human, cadavers, etc

### Introduction

The kidneys are two bean-shaped organs found in vertebrates. They are located on the left and right in the retroperitoneal space, and in adult humans are about 11 centimetres (4.3 in) in length. They receive blood from the paired renal arteries; blood exits into the paired renal veins. Each kidney is attached to a ureter, a tube that carries excreted urine to the bladder.

The nephron is the structural and functional unit of the kidney. Each human adult kidney contains around 1 million nephrons, while a mouse kidney contains only about 12,500 nephrons. The kidney participates in the control of the volume of various body fluid compartments, fluid osmolality, acid-base balance, various electrolyte concentrations, and removal of toxins. Filtration occurs in the glomerulus: one-fifth of the blood volume that enters the kidneys is filtered. Examples of substances reabsorbed are solute-free water, sodium, bicarbonate, glucose, and amino acids. Examples of substances secreted are hydrogen, ammonium, potassium and uric acid. The kidneys also carry out functions independent of the nephron. For example, they convert a precursor of vitamin D to its active form, calcitriol; and synthesize the hormones erythropoietin and renin.

Renal physiology is the study of kidney function. Nephrology is the medical specialty which addresses diseases of kidney function: these include chronic kidney disease, nephritic and nephrotic syndromes, acute kidney injury, and pyelonephritis. Urology addresses diseases of kidney (and urinary tract) anatomy: these include cancer, renal cysts, kidney stones and ureteral stones, and urinary

tract obstruction [1].

Procedures used in the management of kidney disease include chemical and microscopic examination of the urine (urinalysis), measurement of kidney function by calculating the estimated glomerular filtration rate (eGFR) using the serum creatinine; and kidney biopsy and CT scan to evaluate for abnormal anatomy. Dialysis and kidney transplantation are used to treat kidney failure; one (or both sequentially) of these are almost always used when renal function drops below 15%. Nephrectomy is frequently used to cure renal cell carcinoma.

In humans, the kidneys are located high in the abdominal cavity, one on each side of the spine, and lie in a retroperitoneal position at a slightly oblique angle [2]. The asymmetry within the abdominal cavity, caused by the position of the liver, typically results in the right kidney being slightly lower and smaller than the left, and being placed slightly more to the middle than the left kidney [3, 4, 5].

The left kidney is approximately at the vertebral level T12 to L3 [6], and the right is slightly lower. The right kidney sits just below the diaphragm and posterior to the liver. The left sits below the diaphragm and posterior to the spleen. On top of each kidney is an adrenal gland. The upper parts of the kidneys are partially protected by the 11th and 12th ribs. Each kidney, with its adrenal gland is surrounded by two layers of fat: the perirenal fat present between renal fascia and renal capsule and pararenal fat superior to the renal fascia.

The kidney is a bean-shaped structure with a convex and a concave border. A recessed area on the concave border is the renal hilum, where the renal artery enters the kidney and

the renal vein and ureter leave. The kidney is surrounded by tough fibrous tissue, the renal capsule, which is itself surrounded by perirenal fat, renal fascia, and pararenal fat. The anterior (front) surface of these tissues is the peritoneum, while the posterior (rear) surface is the transversalis fascia.

The superior pole of the right kidney is adjacent to the liver. For the left kidney, it is next to the spleen. Both, therefore, move down upon inhalation.

In adult males, the kidney weighs between 125 and 170 grams. In females the weight of the kidney is between 115 and 155 grams [7]. A Danish study measured the median renal length to be 11.2 cm (4.4 in) on the left side and 10.9 cm (4.3 in) on the right side in adults. Median renal volumes were 146 cm<sup>3</sup> on the left and 134 cm<sup>3</sup> on the right [8].

The substance, or parenchyma, of the kidney is divided into two major structures: the outer renal cortex and the inner renal medulla. Grossly, these structures take the shape of eight to 18 cone-shaped renal lobes, each containing renal cortex surrounding a portion of medulla called a renal pyramid [7]. Between the renal pyramids are projections of cortex called renal columns. Nephrons, the urine-producing functional structures of the kidney, span the cortex and medulla. The initial filtering portion of a nephron is the renal corpuscle, which is located in the cortex. This is followed by a renal tubule that passes from the cortex deep into the medullary pyramids. Part of the renal cortex, a medullary ray is a collection of renal tubules that drain into a single collecting duct.

The tip, or papilla, of each pyramid empties urine into a minor calyx; minor calyces empty into major calyces, and major calyces empty into the renal pelvis. This becomes the ureter. At the hilum, the ureter and renal vein exit the kidney and the renal artery enters. Hilar fat and lymphatic tissue with lymph nodes surrounds these structures. The hilar fat is contiguous with a fat-filled cavity called the renal sinus. The renal sinus collectively contains the renal pelvis and calyces and separates these structures from the renal medullary tissue [9].

The kidneys excrete a variety of waste products produced by metabolism into the urine. The microscopic structural and functional unit of the kidney is the nephron. It processes the blood supplied to it via filtration, reabsorption, secretion and excretion; the consequence of those processes is the production of urine. These include the nitrogenous wastes urea, from protein catabolism, and uric acid, from nucleic acid metabolism. The ability of mammals and some birds to concentrate wastes into a volume of urine much smaller than the volume of blood from which the wastes were extracted is dependent on an elaborate counter current multiplication mechanism. This requires several independent nephron characteristics to operate: a tight hairpin configuration of the tubules, water and ion permeability in the descending limb of the loop, water impermeability in the ascending loop, and active ion transport out of most of the ascending limb. In addition, passive counter current exchange by the vessels carrying the blood supply to the nephron is essential for enabling this function.

The kidney participates in whole-body homeostasis, regulating acid-base balance, electrolyte concentrations, extracellular fluid volume, and blood pressure. The kidney accomplishes these homeostatic functions both independently and in concert with other organs, particularly those of the endocrine system. Various endocrine hormones

coordinate these endocrine functions; these include renin, angiotensin II, aldosterone, antidiuretic hormone, and atrial natriuretic peptide, among others.

Nephrology is the subspeciality under Internal Medicine that deals with kidney function and disease states related to renal malfunction and their management including dialysis and kidney transplantation. Urology is the specialty under Surgery that deals with kidney structure abnormalities such as kidney cancer and cysts and problems with urinary tract. Nephrologists are internists, and urologists are surgeons, whereas both are often called "kidney doctors". There are overlapping areas that both nephrologists and urologists can provide care such as kidney stones and kidney related infections. There are many causes of kidney disease. Some causes are acquired over the course of life, such as diabetic nephropathy whereas others are congenital, such as polycystic kidney disease.

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### Methodology

The present study was planned in Department of Anatomy, Prathima Institute of Medical Sciences, Nagunoor, Telangana from January 2007 to July 2008. The study was planned in 30 Cadaveric kidney obtained to institute. Total 30 kidney specimens were obtained out of which 15 are left kidneys and 15 are right kidney. Morphology of the kidneys was studied with the features like length, breadth, thickness, and weight. The arrangement of renal hilar structures was also observed. Approval of the institutional ethical committee was taken prior to conduct of this study.

The weight of the kidneys was also measured using weighing machine. The maximum distance between the upper and lower poles of the kidneys was considered as its length. The maximum distance at the superior pole i.e above hilum and inferior pole i.e below the hilum between the medial and lateral borders was considered as its breadth at superior and inferior pole respectively and maximum width as the thickness of kidneys. The presence of exaggerated hilum, lobulations and cysts in the kidneys were also studied.

### Results & Discussion

Kidneys are the important retroperitoneal organs which maintain the homeostatic function of the body and act as endocrine organs. The present study was done to find out morphological variations of right and left kidneys and describe their significance.

Kidney size is considered as an important indication for many clinical signs It has been shown through previous studies that aging leads to a progressive decrease in kidney

size, especially after middle age. The other influencing factors are age, ethnicity, gender, weight and height. A significant correlation between kidney size and kidney function has been observed in patients with chronic kidney disease (CKD). The renal dimensions might also vary among population of different geographical origin [11]. Tissue masses in the kidney found incidentally are increasing with the diffusion of imaging in cuts and the treatment has considerably changed over the past 20 years and Partial nephrectomy (PN) proves to be the standard due to its good results on the cancer and progress in surgical techniques [12]. Satheesh Naik *et al* showed the measurements of kidneys wherein he observed that weight and dimensions of left kidney were larger than the right kidney [13]. Ranjeet S. Rathore. *et al* reported a study to identify differences in renal measurements in an adult Indian He compared the volume of the kidney with glomerular filtration rate (GFR) and body mass index (BMI), which might be of great relevance in selection of patients undergoing donor nephrectomy [14]. Renal volume assessment is an important parameter in evaluation and follows up of kidney transplant recipients, CRF and hypertension secondary to renal artery stenosis. It is also useful in younger patients with vesico ureteric reflux (VUR) which alters the morphometrical profile of the kidney [15]. The data from the 30 kidney specimens of 15 left and 15 right kidneys were collected in the predesigned format and presented as below.

**Table 1:** Measurements of the Right and Left Kidneys

	Right Kidney	Left Kidney
Length (cms)	7.2 – 14.1	7.6 – 14.3
Breadth (cms)	3.2 – 8.3	3.4 – 8.6
Thickness (cms)	2.4 – 5.2	2.6 – 5.7
Weight (gms)	62 – 193	66 - 207

**Table 2:** Variations in Renal hilar structures

	Right Kidney	Left Kidney
Normal renal hilar structure arrangement (Antero-Posteriorly VAP) (%)	13	12
Variation in renal hilar structure arrangement (Antero-Posteriorly AVP) (%)	2	3

Kidney size is considered as an important indication for many clinical signs and hence it is worth studying. Previous studies showed that aging leads to a progressive decrease in kidney size, especially after middle age [16, 17]. Recently, a significant correlation between kidney size and kidney function was observed in patients with chronic kidney disease (CKD) [18].

From the embryological view point, right renal vein develops from one channel whereas left renal vein develops from several anastomotic channels. Any abnormality during these channel developments could alter the arrangement of renal hilar structures with regard to the renal vein [19]. So, our findings related to renal hilar structural variation is supported by the previous studies [19, 22].

T. Ramesh Rao who found the renal artery of diameter less than 4.15 mm was associated with accessory renal arteries [23]. The average length of left kidney was comparatively longer than the right kidney which correlates with earlier studies. The average breadth and thickness of the kidney is almost the same on both the sides. The renal artery may give

rise to branches normally derived from other vessels, such as the inferior phrenic, hepatic, middle and inferior suprarenal, gonadal, pancreatic, and one or more of the lumbar arteries [24].

It could be possible that the renal dimensions might also vary among population of different geographical origin. However, as not much data is available, renal variations need further exploration. Our further emphasis was on lobulation and renal hilum.

Variations in the origin and course of the renal arterial blood supply occur frequently and are of special interest to the urologists, nephrologists, surgeons and radiologists, with respect to the diseases associated with it.

**Conclusion**

As morphological findings help to determine anatomical variations of kidney, such studies will help to strengthen the current literature. Renal dimensions and hilar structural arrangements could possess significant clinical value. Knowledge of these variation can be utilized in various fields of medical sciences i.e Anatomist, Radiologists and Surgeons for better clinical understanding and outcome.

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