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Original Research Article

# MORPHOMETRIC ANALYSIS OF HUMAN ADULT KIDNEYS: A CADAVERIC STUDY

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## ABSTRACT

**Introduction:** Kidneys are a pair of chief excretory organs which maintain the electrolyte and water balance and also serve as endocrine organs. Kidney size is considered as an important indication for many clinical signs. Congenital anomolies, neoplasia, micro and macrovascular diseases are reported to significantly influence kidney sizes. The deviation of renal parameters from established normal values is an important criterion in diagnosing kidney disease .

**Aims and objectives**: The aim of the study was to determine the renal parameters of human adult cadaveric kidneys.

**Materials and Methods:** Present study conducted with 90 kidneys (45 right and 45 left) obtained from formalin fixed cadavers from the Department of Anatomy, Sri Devaraj Urs medical college, Kolar, Karnataka, India. Their morphological features were studied

**Results**: Among the 45 right kidneys, weight ranged from 62.6 to 170 gms with an average weight of 107.37 gms. The length of right kidneys varied from 7.7 to 11 cms with an average length of 9.22 cms. The breadth of right kidneys at superior pole was in the range of 4 to 5.4 cms with an average being 4.89cms.The breadth of left kidneys at inferior pole was in the range of 4 to 6.2 cms with an average being 4.91cms.The thickness of left kidney ranged from 3 to 4.6 cms with an average thickness of 3.85 cms.Among the 45 left kidneys, weight ranged from 66.9 to 194.6gms with an average weight of 105.18 gms. The length of left kidney varied from 7.6 to 11.5 cms with an average length of 9.29 cms.The breadth of left kidneys at superior pole was in the range of 3.8 to 6.3 cms with an average being 4.91cms.The breadth of left kidneys at inferior pole was in the range of 3.4 to 6 cms with an average being 4.57 cms. The thickness of left kidney ranged from 2.5 to 5 cms with an average thickness of 3.57cms.

**Conclusions**: Morphometric studies of renal dimensions have gained much research attention as they are believed to possess significant clinical importance. Determination of renal anatomical variants should be greatly encouraged to strengthen the current literature and improve the knowledge needed for surgical and radiological intervention.

**KEY WORDS:** Kidney Disease, Renal Parameters, Excretory Organs, Renal Transplantations.

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## INTRODUCTION

Kidneys are a pair of chief excretory organs which maintain the electrolyte and water balance and also serve as endocrine organs. Kidney size is considered as an important indication for many clinical signs. Congenital anomolies, neoplasia, micro and macrovascular diseases were reported to significantly influence kidney sizes. The deviation of renal parameters from established normal values is an important criterion in diagnosing kidney disease [1].

Normally each kidney is bean shaped and has a length of 11 cms, breadth of 6 cms and width of 3 cms. The left kidney is 1.5 cm longer than the right. The average weight of a kidney is 150 grams [2]. Foetal lobulation could persist in the adult life such that the renal outline appears larger than the normal.Morphometric studies of renal dimensions have gained much research attention as they are believed to possess significant clinical importance. It is necessary to distinguish a pathological kidney from a normal sized healthy kidney [2]. Since the therapeutic decisions are often based on the results of measurements, accurate and reproducible normal parameters are of importance[3]. There are few data available in the literature on renal morphometry which were obtained from the radiological investigations like ultrasound, computed tomogram and nuclear magnetic resonance[4,5]. But the anatomical studies on renal parameters are scarce. Determination of renal anatomical variants should be greatly encouraged to strengthen the current literature and improve the knowledge needed for surgical and radiological intervention[6].

## AIMS AND OBJECTIVES

The objectives of the study are to determine the renal length, renal breadth, thickness, presence of exaggerated hilum, lobulations or cysts in human adult cadaveric kidneys.

## MATERIALS AND METHODS

90 kidneys (45 right and 45 left) obtained from formalin fixed cadavers from the Department of Anatomy, Sri Devaraj Urs medical college, Kolar were included in the study. Morphology of the kidneys were studied with the features like length, breadth, and thickness. The measurements were taken by using vernier calipers. (Fig.1)

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. The data obtained was tabulated and analysed statistically.

## RESULTS

Out of the 90 kidneys studied,45 were right and 45 were left. All the 90 kidneys were bean shaped.Among the 45 right kidneys, weight ranged from 62.6 to 170 gms with an average weight of 107.37 gms. The length of right kidney varied from 7.7 to 11 cms with an average length of 9.22 cms. The breadth of right kidneys at superior pole was in the range of 4 to 5.4 cms with an average being 4.89cms.The breadth of right kidneys at inferior pole was in the range of 4 to 6.2 cms with an average being 4.91cms.The thickness of right kidney ranged from 3 to 4.6 cms with an average thickness of 3.85 cms(Table 1 ).

Among the 45 left kidneys, weight ranged from 66.9 to 194.6gms with an average weight of 105.18 gms. The length of left kidney varied from 7.6 to 11.5 cms with an average length of 9.29 cms. The breadth of left kidneys at superior pole was in the range of 3.8 to 6.3 cms with an average being 4.91cms.The breadth of left kidneys at inferior pole was in the range of 3.4 to 6 cms with an average being 4.57 cms. The thickness of left kidney ranged from 2.5 to 5 cms with an average thickness of 3.57cms(Table.2).Only 3 of the right kidneys had exaggerated hilum and 14 of the left kidneys had exaggerated hilum(Fig.2).Only 3 of the right kidneys were lobulated and 9 of the left kidneys were lobulated(Fig.3).3 of the right and left kidneys had cysts ranging from number 1-4(Fig.4).

**Fig.1:** Showing the measurements of kidney using Vernier calipers.

**Fig.2:** Showing Exagerrated hilum in kidneys.

**Fig.3:** Showing lobulations in kidneys.

**Fig. 4:** Showing multiple cysts in kidneys.

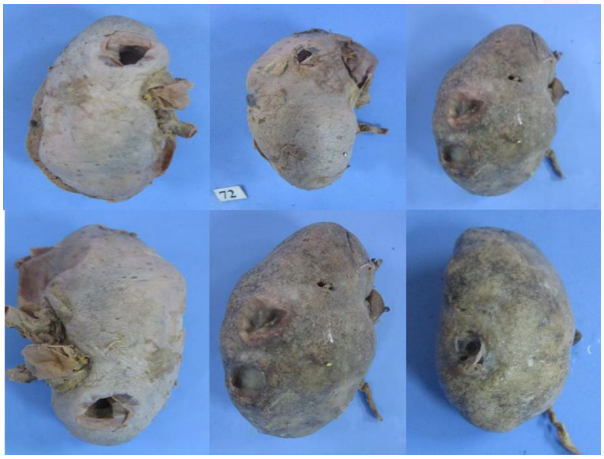

**Fig. 5:** Showing largest and smallest kidney.

Table 1: Morphometric Data Of Right Kidneys (N=45).

| | Right kidneys | | | | |
|---|---|---|---|---|---|
| | Length (Cm) | Breadth At Superior Pole (Cm) | Breadth At Inferior Pole (Cm) | Thickness (Cm) | Weight (Cm) |
| Average | 9.22 | 4.89 | 4.91 | 3.85 | 107.37 |
| Standard Deviation | 0.89 | 0.91 | 0.64 | 0.48 | 28.71 |
| Standard Error | 0.13 | 0.13 | 0.09 | 0.07 | 4.28 |
| Maximum | 11 | 6.1 | 6.6 | 4.6 | 160 |
| Minimum | 7.5 | 4 | 3.7 | 2.6 | 36.7 |

**Table 2:** Morphometric Data Of Left Kidneys (N=45).

| | Left Kidneys | | | | |
|---|---|---|---|---|---|
| | Length (Cm) | Breadth At Superior Pole (Cm) | Breadth At Inferior Pole (Cm) | Thickness (Cm) | Weight (Cm) |
| Average | 9.29 | 4.91 | 4.57 | 3.57 | 105.18 |
| Standard Deviation | 0.9 | 0.59 | 0.6 | 0.45 | 27.65 |
| Standard Error | 0.13 | 0.08 | 0.08 | 0.06 | 4.12 |
| Maximum | 11.5 | 6.3 | 6 | 5 | 194.6 |
| Minimum | 7.5 | 3.8 | 3.2 | 2.5 | 64.9 |

## DISCUSSION

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[6].

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 [7]. 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 [8].

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[9]. Renal volume assessment is an important parameter in evaluation and follow 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[10].

Barton EN et al conducted a sonographic study of 49 randomly selected healthy adult Jamaicans to establish a guide for renal dimensions in the population. There was no difference in width between right or left kidneys in the group as a whole or within either gender[11].Okoye IJ et al studied the renal lengths of 200 adults with normal renal and cardiac to establish normative values of renal length for the locality and to correlate them with some anthropometric parameters. The ranges of normal kidney length obtained were 8.3 -12.8 cm and 8.0- 12.5 cm for the left and right kidneys respectively. The mean renal lengths of males were slightly higher than those of females[12].

Renal length estimation by ultrasound is considered as an important parameter in clinical evaluation of kidney disease and healthy donors. Changes in renal volume may be a sign of kidney disease[13]. Raza M et al determined renal size by ultrasound in adults without any known renal disease wherein the mean renal length on right side was 101.6 +/- 8.9 mm, renal width 42.7 +/- 7.1 mm, and parenchymal thickness 14.4 +/- 2.9 mm. On left side, mean renal length was 102.7 +/- 9.2 mm, width 47.6 +/- 7.0) mm, and parenchymal thickness 15.1 +/- 3.1 mm. Mean renal volume on right was 99.8 +/- 37.2 cm3 and on left was 124.4 +/- 41.3 cm3. Left renal size was significantly larger than right in both genders [14].Gebrehiwot M et al conducted a prospective study and examined eighty adult Ethiopian individuals for kidney size.The size of the kidney was assessed by measurement of the length, cortical thickness and width from intravenous urography (IVU) and found that the left kidney was longer than the right and the mean kidney length was greater in men than in women[15].

Arnerlov C et al conducted a prospective study on 131 patients referred for urography and the mobility of each kidney was measured on the films. The renal mobility was greater among women than among men, and the degree of renal mobility was significantly correlated to low weight and, among women, also to height [16].In the age group of 15-16 years, the mobility of the right kidney was greater than that of the left kidney both in boys and girls. The obtained percentile charts of vertical kidney mobility in children will be useful when nephropexy is to be performed[17].

Muthusami P et al in his study showed that the means of length, width and parenchymal thickness of all 280 kidneys of 140 patients were 9.65 ± 0.63, 4.5 ± 0.42 and 2.04 ± 0.2 cm, respectively. There was a significant difference in parenchymal thickness between the right and left kidneys, while there was no significant right-left difference in length or width [18].Egberongbe AA et al showed that the renal volume was higher in the left than the right kidney in hypertensive patients of both sexes and female hypertensive patients have smaller kidney size compared to males. The study also showed that volume of kidneys decreased with age[19].Sharma N et al showed that semiautomated and freehand scripting measurements of parenchymal volumes are relatively consistent before and after partial nephrectomy, although the semiautomated approach tended to yield volumes that were approximately 5%-10% higher on average[20].

## CONCLUSION

Morphometric studies of renal dimensions have gained much research attention as they are believed to possess significant clinical importance. Determination of renal anatomical variants should be greatly encouraged to

strengthen the current literature and improve the knowledge needed for surgical and radiological intervention. Variations related to renal dimensions are anticipated to furnish better insights on systemic diseases, urinary tract diseases, congenital anomolies, neoplasia, micro and macrovascular diseases which were reported to significantly influence kidney sizes.

**Conflicts of Interests: None**

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