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Assessment of the renal parameters of human cadaveric kidneys: a morphometric study

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ABSTRACT: Background: *Morphometric studies have gained much research attention as they are believed to possess significant clinical importance. Condition like systemic diseases, urinary tract diseases, congenital anamolies, neoplasia, micro and macrovascular diseases were reported to significantly influence kidney sizes dimensions could possess significant clinical value.*
Aims and objectives: *The aim of the study was to determine the renal parameters of human cadaveric kidneys.*
Material and methods: *The present study was the conducted in Department of Anatomy, Patna Medical College and Hospital, Patna ,Bihar,India for 1 year. 120 kidneys (60 right and 60 left) obtained from formalin fixed cadavers were included in the study. Morphology of the kidneys were studied with the features like length, breadth, and thickness.*
Results: *Outofthe120kidneysstudied, 60wererightand 60 were left. Among the 60 right kidneys, weight ranged from 62 to 174 gms with an average weight of 108.02 gms. The length of right kidney varied from 7.6 to 11.4 cms with an average lengthof9.31cms.Thebreadthofrightkidneys at superior pole was in the range of 4.2 to 6.3 cmswithanaveragebeing4.85 cms. Thebreadth ofrightkidneysatinferiorpolewasintherange of 3.5 to 6.8 cmswith an average being 4.95cms.The thickness of right kidney ranged from 2.4 to 4.8 cms with an average thicknessof 3.91 cms. Amongthe60leftkidneys,weightrangedfrom 66.7 to 193.5gms with an average weightof 104.74gms.Thelengthofleftkidneyvariedfrom 7.7 to 11.8 cms with an average length of 9.34 cms.Thebreadthofleftkidneysatsuperiorpole wasintherangeof3.6to6.5cmswithanaverage being 4.91cms.The breadth of left kidneys atinferiorpolewasintherangeof3.4to6cms with an average being 4.61 cms. The thickness of left kidney ranged from 2.3 to 5.2 cms withan averagethicknessof3.61cms.*
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 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 Disease, Renal Parameters, Excretory Organs, Renal Transplantations.*

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I. INTRODUCTION

The kidney is a vital organ of the mammalian body and becomes a foremost subject of medical research because many renal diseases in humans are incurable when the kidney is severely damaged.[1] It is also a primary target organ in preclinical studies, in which drug-induced nephrotoxicity is a recurrent finding in preclinical studies. In acute renal failure, the damaged tubular epithelium is repaired through repopulation,and tubular function recovers in most cases. The tubular epithelium is especially sensitive to toxic compounds because of water and solute absorption and active transport systems, which result in the concentration of toxicants in the tubular cells.[2] Kidneys are a pair of chief excretory organs that not only maintain the electrolyte and water balance but also serve as endocrine organs.[3] 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.[4-5] Kidneys are characterized by a circular and thick superior pole and a pointed and thin inferior pole. The anterior surface is convex and posterior surface is flat.[4] The lateral border is convex, medial border is concave with a hilum that consists of renal vein, renal artery and pelvis of the ureter, anterio-posteriorly.[4] Foetal lobulation could persist in the adult life such that the renal outline appears larger than the normal.[5] In the recent period, morphometric studies have gained much research attention as they are believed to possess significant clinical importance. Most probably, variations related to renal dimensions observed in such studies are anticipated to furnish better insights on anomalies. For instance, conditions like systemic diseases, urinary tract diseases, congenital anamolies, neoplasia, micro and macrovascular diseases were reported to significantly influence kidney sizes.[6] The primary purpose of the renal system is to regulate blood volume, maintain plasma osmolarity and removal of wastage via urine, which is mostly a convenient way to performs

many body functions. The investigational parameters like tubular degeneration, interstitial inflammation, fibrosis, and glomerulosclerosis were considered as significant changes occur during advance stages of chronic kidney disease compared with early stages of the disease. Morphometric studies have gained much research attention as they are believed to possess significant clinical importance. Condition like systemic diseases, urinary tract diseases, congenital anamolies, 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.[7] 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.

II. MATERIAL AND METHODS

The present study was the conducted in Department of Anatomy, Patna, Medical College, Patna, Bihar,India for 1 year.

Methodology

120 kidneys (60 right and 60 left) obtained from formalin fixed cadavers were included in the study. Morphology of the kidneys was studied with the features like length, breadth, and thickness. The measurements were taken by using verniercalipers. 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.

Statistical analysis

The recorded data was compiled entered in a spreadsheet computer program (Microsoft Excel 2010) and then exported to data editor page of SPSS version 20 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included computation of percentages, means and standard deviations were calculated.

III. RESULTS

Out of the 120 kidneys studied, 60 were right and 60were left. All the 120kidneys were bean shaped.Among the 60right kidneys, weight ranged from 62 to 174 gms with an average weight of 108.02gms. The length of right kidney varied from 7.6 to 11.4cms with an average lengthof9.31cms.Thebreadthofrightkidneys at superior pole was in the range of 4.2 to 6.3cmswithanaveragebeing4.85 cms.Thebreadth ofrightkidneysatinferiorpolewas in the range of 3.5to 6.8cmswith an average being 4.95cms.The thickness of right kidney ranged from 2.4 to 4.8cms with an average thicknessof 3.91cms (Table 1).Amongthe60leftkidneys,weightrangedfrom 66.7to 193.5gms with an average weightof 104.74gms.Thelengthofleftkidneyvariedfrom 7.7 to 11.8cms with an average length of 9.34cms.Thebreadthofleftkidneysatsuperiorpole wasintherangeof3.6to6.5cmswithanaverage being 4.91cms.The breadth of left kidneys atinferiorpolewasintherangeof3.4to6cms with an average being 4.61cms. The thickness of left kidney ranged from 2.3 to 5.2cms withan averagethicknessof3.61cms(Table.2).Only5of therightkidneyshadexaggeratedhilumand17of the left kidneys had exaggerated hilum.Only4 of the right kidneys were lobulated and 11of the left kidneys were lobulated.

Table 1: Morphometric Data of Right Kidneys (N=60)

	Right kidneys				
	Length (Cm)	**Breadth At Superior Pole (Cm)**	**Breadth At Inferior Pole (Cm)**	**Thickness (Cm)**	**Weight (gms)**
Average	9.31	4.85	4.95	3.91	108.02
Standard Deviation	0.91	0.89	0.56	0.52	28.11
Standard Error	0.15	0.14	0.13	0.11	4.31
Maximum	11.4	6.3	6.8	4.8	174
Minimum	7.6	4.2	3.5	2.4	62

Table 2: Morphometric Data of Left Kidneys (N=60).

	Left Kidneys				
	Length (Cm)	**Breadth At Superior Pole (Cm)**	**Breadth At Inferior Pole (Cm)**	**Thickness (Cm)**	**Weight (gms)**
Average	9.34	4.94	4.61	3.61	104.74
Standard Deviation	0.85	0.62	0.51	0.51	27.65
Standard Error	0.17	0.11	0.16	0.09	4.12
Maximum	11.8	6.5	5.9	5.2	193.5
Minimum	7.3	3.6	3.3	2.3	66.7

IV. 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.[7]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.[8]Naik S et al. showed the measurements of kidneys wherein he observed that weight and dimensions of left kidney were larger than the right kidney.[9]Rathore RS 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.[10]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.[11]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.[12]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.[13]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.[14]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.[6]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]

In our study among the 60 right kidneys with an average weight of 108.02 gms. The average length of right kidney was9.31cms.Theaverage bread thofright kidneys was4.85 cms. The average breadth ofrightkidneys was 4.95cms.The average thickness was 3.91 cms. Amongthe60 leftkidneys average weight was104.74gms.Theaverage length of left kidney was 9.34 cms.The average breadth was 4.91cms.The average breadth of left kidneys at inferiorpolewas4.61 cms. The average thickness of left kidney was3.61cms. 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]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.

V. 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 variations 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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