

A Morphometric Study of Measurements of kidney in Adults and Its Relation with Age and Height of the Individual with its Clinical Implications

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Abstract

Objective: Renal dimensions are important for the diagnosis of nephropathies. It has been postulated from necropsy studies that variations in renal dimensions and renal weight are related to gender, with weight being higher in males. Thus, the aim of this study was to evaluate the renal dimensions in a south Indian population, and to correlate them with gender, body weight, age, and height. **Materials and methods:** 130 (65 right and 65 left) normal post-mortem kidneys of adults were studied. Age of the individual was noted. Length of the deceased was measured. Length, thickness, breadth and weight of the kidneys were measured. Statistical analysis was done. **Results:** The mean length, breadth, thickness and weight of right kidney in males are 10.3, 5.2, 2.6cm and 140gm while on left side was 10.4, 5.1, 2.7cm and 140gm. In females mean length, breadth, thickness and weight of right kidney are 10.6, 5.4, 2.7cm and 130gm while on left side was 10.2, 5.2, 2.6cm and 140gm. In our study there was a significant correlation between weight of individual with weight, length and breadth of kidney in males. **Conclusion:** There was significant correlation seen between height of individual and weight, length and breadth of kidney in males and also between age of individual and weight, length and thickness of kidney in males. In females there was significant correlation between age of individual and thickness of kidney and weight of individual and length of kidney. This study will also be helpful for nephrologist to diagnose diseases in the kidney like renal tumours, hypertrophy or atrophy.

Keywords: Kidney, Dimensions, nephrology, body height

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Introduction

Renal measurements are vital for the diagnosis and for the prognosis of nephropathies.¹ From 4th decade up to 8th decade of life the human kidneys lose roughly a fifth of their weight. Kidneys with length less than 8 cm are considered as contraindication for intervention of renal arterial disease.² Renal dimensional variations can occur in nephropathies due to hypertrophic process and/or atrophy.¹

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Renal dimensions can play a significant role in the decision for renal biopsy, renal transplant or avoiding immunosuppressive treatment.³ Renal dimensions are evaluated for the loss of kidney mass and thus for kidney function.⁴ Renal inflammations, nephrologic conditions, diabetes mellitus and hypertension are the most vital co-morbid situations affecting renal size.⁵⁻⁷ Serial measurements can also provide information about disease progression or steadiness.

Factors such as glomerulosclerosis and tubulointerstitial fibrosis might lead to a reduction in renal size and weight, as histological data reveals a reduction in the number of cortical glomerules by 30-50% at the age of 70 years, as well as observing a loss of glomerular lobulation, increasing

mesangial volume and glomerular collapse, as well as intimal thickening hyalinosis of both the arteries and the arteriola.^{8, 9} On the other hand, there is an increase in kidney size in initial stage renal thrombosis, initial stage diabetes mellitus and renal inflammation.^{6, 10} It has been proposed from necropsy studies that discrepancies in renal measurements and renal weight are linked to gender, with weight being higher in males. Other studies have also tried to establish a correlation between renal dimensions and age, since it was shown that a reduction of up to 40% in renal weight occurs as the age advance.¹ As the renal size is affected by several causes, it is essential to first establish the normal values. The measurements established and stated in our standard anatomy and urology textbooks reveal the western country measurements and cannot be applied to our country. The renal measurements will differ as we move from one geographical area to another.¹¹ Thus, the aim of this study was to evaluate the renal dimensions in a south Indian population, and to correlate them with gender, body weight, age, and height.

Materials and Methods

In this study 130 normal post-mortem kidneys, 65 right and left kidneys of same adults of both male and female with their age ranging from 18-85 years were taken from the mortuary of Department of Forensic Medicine. The specimens were washed thoroughly with tap water and gently squeezed to remove the blood clots from the lumen of blood vessels. Specimens were then taken in a tray and associated fat, fascia, nerves and other unwanted tissues were removed. Kidneys which were looking abnormal or diseased to naked eye or those cases whose death occurs due to kidney diseases or those who were having any kidney diseases in the past were excluded from the study.

Length of the deceased was measured with a measuring tape.

Length, thickness and breadth of the kidneys were measured with measuring tape. The

major distance between the renal poles (superior and inferior) was taken as the length of the kidney. The major distance between the lateral and medial borders perpendicular to the length was taken as the width of the kidney. The breadth was measured at the region of maximum antero-posterior diameter. Weight was measured with weighing machine. Statistical analysis of the parameters was done using Pearson correlation, paired sample T test and independent sample T test.



Figure 1: Showing the measurements done on kidney. A. Length of kidney, B. Breadth of kidney, C. Thickness of kidney.

Results

The mean and range of all parameters of male and female kidney of both sides are shown in table 1. In our study the average length, breadth and thickness of right and left kidney are 10.42 ± 1.28 , 5.31 ± 1.03 , 2.68 ± 0.74 cm and 10.41 ± 1.35 , 5.19 ± 1.01 and 2.70 ± 0.76 cm. In our study the mean weight of right and left kidney was 140.2 ± 41.5 and 144.8 ± 43.3 gms.

There was no significant relation between any parameters of kidney on right and left side in both males and females. But there was significant relation between weight of right and left kidney in total cases. Paired T test value for significant relations between all parameters of right and left side in males, females and total cases are shown in table 2.

There was no significant relation in any parameters of kidney between males and females. The P values of independent sample T-test for weight, length, breadth and thickness are 0.72, 0.76, 0.70 and 0.81.

There was no significant correlation between age of individual and any parameters of

kidney in males. But there was significant correlation between height of individual and weight, length and thickness of kidney and also between weight of individual and weight, length and breadth of kidney in males. Rest of parameters there was no significant correlation. The values of Pearson correlation tests are shown in table 3. There was no significant correlation between height

of individual and any parameters of kidney in females. But there was significant correlation between age of individual and thickness of kidney and also between weight of individual and length of kidney in females. Rest of parameters there was no significant correlation. The values of Pearson correlation tests are shown in table 4.

Table 1. Showing mean and range of all parameters of male and female kidney of both sides.

Parameters		Male		Female	
		Right	Left	Right	Left
Length (cm)	Mean \pm SD	10.3 \pm 1.3	10.4 \pm 1.31	10.6 \pm 1.24	10.2 \pm 1.47
	Range	7-13.5	7-14	7-12	6.5-12
Breadth (cm)	Mean \pm SD	5.2 \pm 0.97	5.1 \pm 0.91	5.4 \pm 1.19	5.2 \pm 1.23
	Range	3.5-7.5	3.5-8	3.5-7.5	2-7
Thickness (cm)	Mean \pm SD	2.6 \pm 0.74	2.7 \pm 0.78	2.7 \pm 0.75	2.6 \pm 0.72
	Range	1.5-5	1.5-5.5	1.5-4.5	1.5-4.5
Weight (gms)	Mean \pm SD	140 \pm 0.04	145 \pm 0.04	138 \pm 0.04	142 \pm 0.03
	Range	80-240	80-280	60-220	80-220

Table 2. Showing paired T test value for significant relations between all parameters of right and left side

T-test	Weight of kidney			Length of kidney			Breadth of kidney			Thickness of kidney		
	M	F	Total	M	F	Total	M	F	Total	M	F	Total
P value	0.06	0.41	0.04*	0.79	0.24	0.94	0.20	0.47	0.21	0.42	0.54	0.79

*indicates significant values < 0.05 . M= Males; F= Females.

Table 3. Showing Pearson correlation values between all parameters of kidney in males with all general parameters of individual.

Parameters	Age of individual	Height of individual	Weight of individual
Weight of kidney	0.43	0.00*	0.00*
Length of kidney	0.63	0.02*	0.002*
Breadth of kidney	0.09	0.22	0.04*
Thickness of kidney	0.25	0.04*	0.056

*indicates significant values < 0.05 .

Table 4. Showing Pearson corelation values between all parameters of kidney in females with all general parameters of individual.

Parameters	Age of individual	Height of individual	Weight of individual
Weight of kidney	0.25	0.23	0.28
Length of kidney	0.25	0.15	0.02*
Breadth of kidney	0.32	0.09	0.32
Thickness of kidney	0.02*	0.52	0.61

*indicates significant values < 0.05.

Table 5. Comparision of our results with other authors

Parameter	Sampaio FJ, Mandarin-de-Lacerda CA		Setty SRS, Katikireddi RS		Emamian SA et al		Niels-Peter Buchholz NP et al		Brandt TD et al		Present study	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Weight (gms)	-	-	103.04	114.48	-	-	-	-	-	-	140.2	144.8
Length (cm)	10.97	11.21	10.92	11.32	10.9	11.2	10.4	10.5	10.74	11.10	10.42	10.41
Breadth (cm)	-	-	6.2	6.62	-	-	4.2	4.8	-	-	5.31	5.19
Thickness (cm)	3.21	3.37	3.34	3.54	-	-	-	-	-	-	2.68	2.70

Discussion

Renal dimensions are clinically significant, serving as substitutes for renal functional reserve, and are used normally as the basis for making clinical judgements. Renal disease can increase or decrease renal size, and may or may not be accompanied by alterations to the normal organ structure.¹¹

Sampaio FJ, Mandarin-de-Lacerda CA values of average length, thickness of right and left kidney were slightly more than our study this may be because they have done the study on Brazilian population and we have done the study in Indian population.¹² (Table 5)

Gupta et al and Fernandes et al found that the average length, breadth of right kidney as 8.9, 4.7cm and 12.03, 5.64cm in males and 8.9, 4.3cm and 12.01, 5.62cm in females while in our study the values are 10.3, 5.2cm in males and 10.6, 5.4cm and in females of right kidney respectively. Gupta et al and Fernandes et al found that the average length, breadth of left kidney as 9.1, 4.7cm and 12.67, 6.07cm in males and 8.9, 4.2cm and 12.59, 5.99cm in females while in our study the values are 10.4, 5.1cm in males and

10.2, 5.2cm and in females of left kidney respectively. Even Fernandes et al have done the study on Brazilian population so their values are more as compared to ours and we have done the study in Indian population. While Gupta et al have done the study on ultrasonographic images of north East Indian population that's why their values are less than our values.^{1, 11}

Setty SRS, Katikireddi RS values were slightly more than ours this may be because they have done the study in different region like Andhra Pradesh and we have done in Karnataka region. Our weight of kidney was more as compared to their results.¹³

Emamian SA et al have done the study using ultrasound that's why their results were more as compared to our results. They found that the renal length correlated best with body height which was similar to our study we also got significant correlation between renal length and body height in males.¹⁴ (Table 5) Wang F et al found the mean length of the right, left kidney in males and females as 10.2, 10.5cm and 9.8, 10 cm while in our study the values are 10.3, 10.4cm and 10.6,

10.2cm. Our values were almost similar to their result.¹⁵

Niels-Peter Buchholz NP et al and Brandt TD et al have done the study using ultrasound images so kidney length of Niels-Peter Buchholz NP et al was almost similar to ours but Brandt TD et al kidney length was more as compared to ours. But our width of kidney was more than Niels-Peter Buchholz NP et al study.^{16, 17} (Table 5)

A physiological increase of glomerular filtration rate and kidney size can be observed in pregnancy.¹⁸ Kidney size also increases with increased protein intake in mice.¹⁹ The renal measurements of a patient are a very beneficial diagnostic parameter both in urological as well as nephrologic practice.¹¹ Disorders like systemic ailments, urinary tract infections, congenital anomalies, neoplasia, micro and macrovascular diseases were reported to significantly influence kidney dimensions.²⁰ This study will be helpful for forensic experts and for clinicians as in our study we got significant correlation between height and weight of individuals with various parameters of kidney in males and females. But there was not much significant relation between right and left side of the same individual.

Conclusion

In our study there was significant correlation seen between height of individual and weight, length and breadth of kidney in males and also between age of individual and weight, length and thickness of kidney in males. In females there was significant correlation between age of individual and thickness of kidney and weight of individual and length of kidney. This study will also be helpful for nephrologist to diagnose diseases in the kidney like renal tumours, hypertrophy or atrophy.

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