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SONOGRAPHIC ASSESSMENT OF NORMAL RENAL SIZE IN INDIAN ADULT POPULATION

Radiodiagnosis

Dr. Anupama Jain Associate Professor, Department Of Radiodiagnosis, M.L.B. Medical College, Jhansi.

Dr. Ritika Kesarwani* Junior Resident, Department Of Radiodiagnosis, M.L.B. Medical College, Jhansi.
* Corresponding Author

Dr. Amit Kumar Ranjan Junior Resident, Department Of Radiodiagnosis, M.L.B. Medical College, Jhansi.

ABSTRACT

INTRODUCTION: Kidney length is a very important indicator of kidney function. Kidney size is affected by an array of conditions. Sonography is the simplest way to assess it. Most of the data we have on adult renal nomograms are of Western population and the results are not quite applicable to our Indian population which leads to mismanagement of patients and thus demands the need of a study to establish normal values of renal size in Indian adult population.

MATERIALS & METHODS: Sonographic assessment of normal renal dimensions of 1000 patients of age >18 years with no renal disease and analysis of the data was performed and its dependence on age, gender & laterality was seen.

RESULTS: Mean renal length was 92.94 ± 9.69 mm (Range-75mm-125mm). Mean length of right kidney was 91.40 ± 9.56 mm whereas mean length for left kidney was 94.48± 9.57mm.

KEYWORDS

Ultrasound, Renal Size, Renal Length.

INTRODUCTION:

The kidney size is an important parameter for evaluation of renal function in daily clinical practice of renal diseases. Despite having a large burden of kidney diseases especially chronic kidney disease in India there is dearth of normal data on renal size in adult Indian population. Renal dimensions, especially length is considered surrogate marker for renal status in routine clinical evaluations[2,3,4.] Measuring kidney size using ultrasound is established as a reliable method in most clinical settings[6,7,8.] Ultrasound has been shown to have good accuracy as well as inter and intra-observer reproducibility for renal length measurement[9,10,11,12,13]

CT AND MRI provide possibility of more reliable volumetric assessment of renal size and volume. Despite this, sonographic renal size estimation remains popular due to its availability, ease of performance, cost effectiveness, portability and repeatability and without any administration of contrast or ionizing radiation.

A renal length (pole to pole) of 9 cm, widely accepted as the cut-off to indicate irreversible renal disease in most populations[6,11], is a size often seen in normal and healthy Indian adults. Considering that in most hospitals, important clinical decisions including renal failure determination, treatment follow up and transplant and biopsy related decisions are made based on sonographic dimensions, it is imperative to have benchmark parameters in our population group. We undertook this study to collect preliminary nomographic data on sonographic renal dimensions in Indian adults and set a standard for comparison and to see its relation with age, gender and laterality.

MATERIALS & METHODS:

A total of 1000 patients of >18 years of age were included in this prospective, cross-sectional analysis. This study was conducted between May 2019 and September 2019 in the Department of Radiodiagnosis, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India. Informed consent was taken from all participants. The measurements were made using a 3.5 MHz curvilinear transducer on two ultrasound devices (Hitachi Aloka SSD F-31 and Sono ACE-X8 Medison) in our department. All the participants were asked to empty their bladder before the examination to prevent erroneous measurement of renal size due to hydration induced increment in renal size. Renal length measurements were taken in supine, prone and decubitus position and the final reading was obtained whichever was more. For renal width, transverse cross sectional image of kidney was taken. The criteria for measurement of renal length and width were clearly pre-determined. Renal length was defined as the longest pole to pole measurement while width was defined as the maximum dimension in transverse cross sectional image of the kidney.

Participants included patients referred for ultrasound for non-renal indications with the following inclusion criteria: Serum creatinine within last six months ≤ 1.5mg/dl, effective glomerular filtration rate (eGFR) calculated using the modification of diet in renal disease (MDRD) formula > 30 ml/min/m2,, normotensive at the time of ultrasound examination (systolic blood pressure < 140 mmHg and diastolic blood pressure < 90 mmHg), patients having normal sonographic appearance of kidneys.

Patients with following criteria were excluded: Symptoms suspected for kidney pathology like flank pain, hematuria, fever, any lower urinary tract symptoms(LUTS), or a history of any renal disease including calculus disease, or history of any acute or chronic disease capable of causing renal damage, patients with prior abdominal surgery for renal causes, patients on treatment with any nephrotoxic drugs, pregnant women, patients with known diabetes or hypertension and patients with any abnormality in renal sonogram e.g, any renal cyst, tumour, dilated calyces, congenital anomalies, abnormal area of echogenicity, poor cortico-medullary junction differentiation, etc. Statistical analysis was then applied to the data generated.

RESULTS:

A total of 2000 kidneys were analysed in 1000 patients out of which 560 patients were males (56%) and 440 patients were females (44%). The mean age was 41.18 ± 17.81 years ranging from 18 years to 96 years. The distribution of age in the study population is shown in Table 1.1.

Table 1.1: Age distribution of study subjects.

Age in years	No.	%
18-30 years	374	37.4
31-40 years	181	18.1
41-50 years	152	15.2
51-60 years	116	11.6
61-70 years	121	12.1
>70 years	56	5.6
Total	1000	100.0

Overall mean renal length obtained was 92.94 ± 9.69 mm with a range of 75mm-125mm and mean renal width was 43.96 ± 5.76mm.

Overall, mean length of right kidney was 91.40 ± 9.56 mm whereas the mean length for left kidney was 94.48 ± 9.57mm.

Overall, mean width of right kidney was 43.53 ± 5.75mm and the mean width of left kidney was 44.40 ± 5.41mm.

Comparison of parameters between right and left kidney is shown in Table 1.2 and Table 1.3

Table 1.2 - Comparison of parameters between right and left kidney.

	Mean	SD	95% CI for Mean		P value
			Lower Bound	Upper Bound	
Length right kidney (mm)	91.40	9.56	90.43	92.72	<0.01
Length left kidney (mm)	94.48	9.57	93.52	95.43	
Width right kidney (mm)	43.53	5.75	42.92	43.97	0.04
Width left kidney (mm)	44.40	5.41	43.97	44.86	

Table 1.3- Central tendencies obtained of the renal parameters in both the kidneys (IQR- Interquartile range, SD- Standard Deviation)

	Age (years)	Length right kidney (mm)	Width right kidney (mm)	Length left kidney (mm)	Width left kidney (mm)
Mean	41.18	91.40	43.53	94.48	44.40
Median	38.00	90.00	43.00	94.00	44.00
IQR	26-55	85-98	40-47	88-100	41-47
SD	17.819	9.563	5.756	9.575	5.414
Minimum	18	75	30	75	31
Maximum	96	124	60	125	60

In males, mean renal length was 93.90 ± 10.31mm and mean width was 44.15 ± 5.76mm whereas in females, mean renal length was 91.71 ± 8.68mm and mean width was 43.73 ± 5.38mm.

In males, mean length of right kidney was 92.42 ± 10.22mm whereas mean length of right kidney in females was 90.09 ± 8.48mm. Similarly, In males, mean length of left kidney was 95.38 ± 10.20 mm whereas mean length of left kidney in females was 93.33 ± 8.58 mm.

Comparison of renal parameters between males and females in shown in Table 1.4 and Fig 1a and 1b.

Table 1.4 - Comparison of renal parameters between males and females

	Gender	Mean	SD	95% CI for Mean		P VALUE
				Lower Bound	Upper Bound	
Length right kidney (mm)	Male	92.42	10.22	91.6	93.3	<0.01
	Female	90.09	8.48	89.31	91.12	
Width right kidney (mm)	Male	43.82	5.95	43.29	44.35	0.07
	Female	43.16	5.48	42.67	43.74	
Length left kidney (mm)	Male	95.38	10.20	94.52	96.34	<0.01
	Female	93.33	8.58	92.43	94.23	
Width left kidney (mm)	Male	44.48	5.55	44.03	44.96	0.58
	Female	44.29	5.24	43.81	44.76	

Significant difference was noted in renal lengths of right and left kidneys (p value: < 0.01) and in between renal widths of right and left kidneys. (p value :< 0.04)

Significant gender differences were obtained for renal lengths but not for renal widths (For right renal length, p value= < 0.01; For left renal length, p value= < 0.01; For right renal width p value= 0.07; For left renal width p value= 0.58).

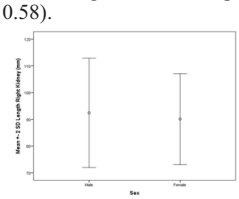

Figure 1a : Error plot showing Right kidney length between male and female

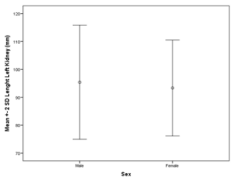

Figure 1b : Error plot showing left kidney length between male and female

Table 1.5: Renal parameters in all age groups.

	Age category	Mean	SD	95% CI for Mean		Min.	Max.	P VALUE
				Lower Bound	Upper Bound			
Length right kidney (mm)	18-30	93.74	8.87	92.84	94.64	75	124	<0.01
	31-40	94.35	9.27	92.99	95.71	75	124	
	41-50	92.30	8.77	90.90	93.71	75	120	
	51-60	89.00	9.27	87.29	90.71	75	115	
	61-70	84.71	7.93	83.28	86.14	75	117	
	>70	83.13	8.24	80.92	85.33	75	115	
Width right kidney (mm)	18-30	43.74	5.26	43.21	44.28	30	59	<0.01
	31-40	44.54	6.05	43.65	45.43	30	60	
	41-50	44.48	6.33	43.46	45.50	30	60	
	51-60	43.46	5.80	42.39	44.53	31	57	
	61-70	41.43	5.54	40.43	42.43	30	60	
	>70	40.95	4.84	39.65	42.24	31	56	
Length left kidney (mm)	18-30	96.72	8.87	95.82	97.63	77	125	<0.01
	31-40	97.38	9.38	96.00	98.75	76	125	
	41-50	95.98	9.08	94.52	97.44	76	124	
	51-60	91.72	9.18	90.03	93.41	76	120	
	61-70	87.86	7.26	86.55	89.17	78	114	
	>70	86.02	8.45	83.75	88.28	75	116	
Width left kidney (mm)	18-30	44.62	5.01	44.11	45.13	31	59	<0.01
	31-40	45.31	6.16	44.41	46.22	32	60	
	41-50	45.56	6.01	44.60	46.52	31	60	
	51-60	43.66	4.99	42.75	44.58	32	58	
	61-70	42.80	4.62	41.97	43.63	31	57	
	>70	41.75	4.35	40.58	42.92	33	58	

Correlation between renal length and age was assessed by Pearson's correlation coefficient (r) and value of -0.362 was obtained for both the kidneys suggesting a moderate negative correlation of renal length with age. Correlation between renal width and age was also assessed and a correlation coefficient (r) of -0.143 for right kidney and -0.150 for left kidney was obtained suggesting a mild negative correlation of renal width with age. Using ANOVA and Posthoc test p value was obtained among all the age groups and decline in renal length was noted after 50 years of age and in renal width after 60 years of age. The decline in renal length accelerated after the age of 60 years. Renal parameters in all the age groups are shown in Table 1.5 and correlation between age and length of Right kidney and Left kidney are shown in Fig 2a and 2b respectively.

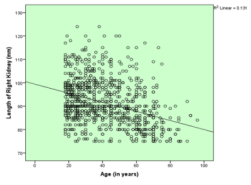

Figure 2a : Scatter plot showing correlation between age and length of Right kidney

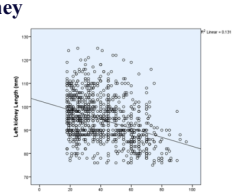

Figure 2b : Scatter plot showing correlation between age and length of Left kidney

DISCUSSION:

Renal length of 9 cm has been widely accepted as cut off value to indicate irreversible renal disease[6,11]. Our study showed that commonly quoted adult renal parameters mostly derived from studies performed in Caucasian populations, were not applicable to the Indian population (shown in Table 1.6). Our results regarding mean renal length were similar to the previous studies that have been done in Indian adults[13,14,15] and differed from studies performed in other parts of the world[5,6,7,9,16,17,18,19,20,21,22,26].

Table 1.6: Comparison of renal length of adult Indian population in our study with the other countries.

Country	Method	Sample size	Mean right renal length (mm)	Mean left renal length (mm)
India (This study)	Ultrasound	1000	91.40	94.48
Mexico5	Ultrasound	153	104.3	105.8
Denmark9	Ultrasound	665	109	112
USA16	Ultrasound	-	107.4	111
Iran26	Ultrasound	400	109	111
Jamaica17	Ultrasound	49	97	100
Pakistan6	Ultrasound	194	104.5	104.5
Nigeria18	Ultrasound	200	103	106
South Korea19	Ultrasound	125	102	105
Kuwait20	Ultrasound	252	106.8	107.1
Austria7	MDCT	1040	108.4	111.3
Iran21	CT	100	108.37	109.74
Malaysia22	Ultrasound	205	102 (In males) 98 (In females)	105 (In males) 100 (In females)

Like most of the studies[4,7,9,14,24] we found out that the left renal length was longer than the right with a statistical significance(p value < 0.01) unlike studies[13] which showed no right to left difference in renal length. This difference in laterality of renal length was noted regardless of sex and age. In our study left renal width also came out to be more than the right renal width. (p value < 0.04)

Similarly, like most studies[7,24] we also noted renal length was more in males as compared to females with a statistical difference (p value < 0.01) unlike few studies which showed no significant gender variations[13,25]. No significant difference (p value- 0.07 for right kidney and p value - 0.58 for the left kidney) was noted in renal width between males and female patients.

In this study we also concluded that bilateral renal length showed a negative correlation with age after 50 years i.e it decreases gradually after 50 years of age and then the decline is accelerated after 60 years of age. Age related decline in renal length was also noted in other studies[5,26].This is important in following up of cases with renal diseases and also in deciding normal parameters of renal size in older age group.

Renal width also showed negative correlation with age and it decreased after 60 years of age (p value < 0.01)

Advantages of this study was it included a large sample size with large number of patients in each age group and across various ethnicities for better representation of the Indian population and to get a better statistical analysis of the data. However, limitations of our study were: Subjects included were patients with non-renal diseases and not healthy adults and thus we need to have data for renal nomograms in healthy Indian adults. Inter-observer variation occurred in our study and it needs to be considered however intra-observer variation was minimised by taking multiple readings for a patient[23]. Our data was collected from a single hospital in North India and we need to have a study for renal nomograms across the country. We did not include other variables like height, weight, BMI, BSA, etc in our study to see its correlation with renal parameters as these variables are indirectly dependant on race of the population.

CONCLUSION:

Indian renal size is smaller than the Western world and therefore the data from their studies shouldn't be applied to our population blindly. Left renal length and width is more than the right irrespective of gender and age. Our study also demonstrated that males have more renal length than females for both the kidneys. With age renal length(after 50 years) and renal width (after 60 years) declines and it should not be misinterpreted.

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