

## Original Article

# Sonographic Measurement of Absolute and Relative Renal Length in Healthy Isfahani Adults

A. Hekmatnia MD\*, M. Yaraghi MD\*\*

## ABSTRACT

**Background:** There is no information on renal size and its relation to age, sex and height in the area of Isfahan. The aim of this study was to define sonographically measured absolute renal lengths and their relations to height in normal Isfahani adults.

**Methods:** 400 healthy Isfahani subjects aged 20 to 69 years with normal blood pressure, no history of renal disease in them or their first degree relatives and with normal sonographic appearance were chosen in 2002-2003. The study was cross-sectional. With real-time sonography, absolute renal length was measured.

**Results:** Four hundred healthy adults (230 men and 170 women) aged 20 to 69 years ( $39.6 \pm 13.6$  year) were evaluated. The length of left kidney was longer than the right one ( $111 \pm 9.8$  mm vs.  $109 \pm 8.4$  mm in right kidney;  $P < 0.01$ ). Renal length was significantly greater in males compared to females ( $P < 0.01$ ). Renal length decreased with age and the rate of decrease was accelerated at the age of 60 years and older. There was a significant correlation between kidney length and the subject's height ( $P < 0.01$ ).

**Conclusion:** The result of this study shows the normal values for renal length in Iranian males and females, which may be helpful in assessing the size of patients' kidneys in different clinical settings.

**Key words:** Kidney size, Renal length, Ultrasonography, Normal values.

Decrease or increase in kidney size is an important sign of renal disease. Renal size can be estimated by measuring renal length, renal volume and cortical volume or thickness<sup>1, 2</sup>. Renal volume is the most accurate measurement of kidney size because it is correlated with the subject's height, weight and total body area<sup>3-6</sup>, but renal volume is not a precise method due to high inter-observer variation. Renal length is a simple, practical and reproducible measurement of renal size<sup>1, 7, 8</sup>, but individual variations such as height, body area, gender and age are not considered in this measurement. In this study we measured the renal length in healthy adult volunteers and analyzed its relationship with height, age, and sex.

## Materials and Methods

This study was carried out during the period from September 2001 to September 2002. The study was cross sectional. A total number of 400 healthy volunteers, free from any physical problems were chosen. Height was measured on subjects without shoes or hat rounded to the nearest 0.5 cm, using a measuring scale. To measure height, the measurement scale was fixed to the wall. Height was measured while the subject stood with heels, buttocks, shoulders and occiput touching the vertical scale. The head was held upright with the external auditory meatus and the lower border of the orbit in the same horizontal plane. All measurements were taken by the same observer. Real time sonography was performed on 400 subjects who had no acute or chronic renal diseases, had a negative family history of renal

\* Assistant professor, Department of Radiology, Isfahan University of Medical Sciences, Isfahan, Iran.

\*\* Radiologist, Isfahan, Iran.

Correspondence to: Dr Ali Hekmatnia, Al-Zahra Medical Center, Isfahan University of Medical Sciences, Isfahan, Iran.

disease and were normotensive. Sonography was done using a 3.5 mega Hertz probe (Hitachi instrument, Tokyo, Japan) and by the same operator each time. Subjects had normal kidney appearance in conventional sonography and their bladders were empty. Renal length was measured as the longest longitudinal diameter. The relative renal length calculated by dividing the absolute renal length (in millimeters) by the subject body height (in centimeters) for each kidney (Kidney-body height ratio, KBR).

Data were presented as mean  $\pm$  SD. Mann-Whitney U test was used to compare the absolute and relative renal lengths between subgroups (sex and age subgroups). Paired data (data of left and right kidneys) were compared using Wilcoxon rank test. Bivariate correlations were tested with Pearson correlation analysis. Two-factor analysis of variance was performed to compare subgroups of ages and genders with respect to renal length. Multivariate regression analysis was performed to examine the relationship of different independent factors (e.g. age, sex, height) with renal length. A P value  $<$  0.05 was considered as statistically significant. Data were analyzed on computer using SPSS 10.0 software.

## Results

From 450 cases that were initially chosen, 50 were excluded based on exclusion criteria. These criteria included: cortical thickness less than 1 cm (25 cases), Cortical or parapelvic cyst larger than 2 cm (16 cases), no corticomedullary differentiation (8 cases) and ectopic kidney (1 case).

Analysis of sonographic measurement included 400 subjects, 230 males and 170 females without any renal abnormality or impairment in the age range of 20 to 69 years ( $39.6 \pm 13.6$  year). The mean height was  $171 \pm 6$  cm (range: 163-183 cm) for men, and  $159 \pm 5$  cm (range: 159 – 168 cm) for women. A significant difference ( $P < 0.01$ ) was seen between absolute length of the left ( $111 \pm 9.8$  mm, range: 89-138 mm) and the right ( $109 \pm 8.4$  mm, range: 88-128 mm) kidneys.

A significant positive correlation between absolute renal length and subject height was found (left kidney,  $r = 0.65$ ,  $P < 0.01$  and right kidney,  $r = 0.66$ ,  $P < 0.01$ ).

The mean KBR for the left kidney was significantly higher than the one for the right ( $0.665$

$\pm 0.045$  vs.  $0.653 \pm 0.047$  for the right kidney;  $P < 0.01$ ).

The difference in absolute renal length between men and women was significant for both kidneys (left kidney:  $113 \pm 10.4$  mm for men vs.  $109 \pm 7.8$  mm for women; right kidney:  $110 \pm 9.18$  mm for men vs.  $107 \pm 6.37$  mm for women;  $P < 0.01$ ).

The difference in relative renal length between men and women was significant for both kidneys (left kidney:  $0.655 \pm 0.06$  for men vs.  $0.677 \pm 0.045$  for women; right kidney  $0.640 \pm 0.055$  for men vs.  $0.684 \pm 0.043$  for women;  $P < 0.01$ ). Mean absolute and relative lengths were correlated with the age of the subjects (table 1).

The variability of KBR was lower than the variability of absolute renal length (left kidney 6.8% and right kidney 7.2% vs. variability of absolute renal length, left kidney 8.8% and right kidney 7.7% in terms of percent variation)

Pearson coefficients of correlation between age and left and right lengths were -0.42 and -0.45, respectively ( $P < 0.01$ ). A stronger correlation with age was found using KBR, which resulted in Pearson coefficients of -0.45 (left kidney;  $P < 0.01$ ) and -0.49 (right kidney;  $P < 0.01$ ).

Within group variation was significantly greater ( $P < 0.05$ ) for the right kidney in subjects aged 20-29 years and for both kidneys in subjects aged 50-59 years compared to those between 60-69 years old. There was no significance between group differences for subjects up to 59 years old.

ANOVA showed no significance between group variability in differences between left and right absolute and relative renal lengths ( $P > 0.05$ ). Multivariate regression was used to examine the relationship between age, sex, and height as predictor variables and left or right renal lengths as dependent variable. Sex was not a significant predictor of length for either kidney when height and age were included in regression.

## Discussion

Sonographic assessment of patients with renal impairment commonly includes measurement of bipolar renal length. Evaluated interobserver and intraobserver variations in renal length measurement found that magnitude of variation is similar whether the left or right kidney is measured and whether measurements are made by one or multiple

sonographers. This suggests that sonographic bipolar length measurements of normal adult kidneys are reasonably reliable<sup>9, 10</sup>. Renal length measurement is the best choice for clinical use because it can be easily obtained and reproduced<sup>3, 11, 12</sup>.

A reduction in renal length (with a cut off point of 8.5 cm or less) indicates irreversible disease. In many of previous measurements of renal length, differences in body height, sex and age which may influence renal length were ignored<sup>4, 5, 8, 13, 14</sup>.

In this study a significant differences between absolute and relative length of left and right kidneys in 400 subjects was found. This finding is confirmed with other studies<sup>4</sup>. Due to a significant correlation between renal length and body height, KBR seems to be a better index for estimating kidney length.

This study showed smaller variability of KBR than the absolute renal length, so the former parameter is more precise.

This study also showed that absolute renal lengths of both kidneys in males were significantly larger than in females<sup>3, 7, 10, 14</sup>. This finding confirmed previous studies that indicated sex differences in renal length. Probable difference between absolute renal length of male and female may be due to difference in gender specific anthropometric data. These results also are reported by Emmamian et al<sup>4, 5, 8</sup>

and Miletic et al<sup>10</sup>. In our study significant decrease in absolute and relative renal length in the age group 60-69 years old was seen. The result of this study shows that renal length gradually decreases with increase in age and this decrease accelerates after the age of sixty years. Similar findings are also shown by Miletic et al<sup>10</sup>. They showed that decrease in absolute and relative renal length is significant in subjects between 60-69 years old ( $P < 0.05$ ) and is highly significant in much older subjects ( $P < 0.01$ ). However the difference in the absolute and relative lengths between the left and right kidneys does not significantly change at any age.

Multiple linear regression analysis used in this study can be used for predicting normal renal length (lower and upper limits) in a subject. Also normal differences between right and left kidney lengths can be used for evaluation of unilateral kidney size. Finally this study showed relative kidney size is a better method for estimation and comparison of kidney size in different subjects, because it eliminates variations related to subject's height and sex. With relative renal length, even age related differences can be eliminated up to the age of 59 years.

**Table 1.** Mean values of Absolute Renal Lengths in mm for the right (R) and the left (L) kidneys by age and sex.

Female			Male				Age group (year)
Absolute Renal Length			Absolute Renal Length				
L	R	N	L	R	n		
110	107	37	114	113	77	20-29	
110	106	34	114	112	68	30-39	
109	106	29	113	112	59	40-49	
108	105	20	112	109	40	50-59	
105	104	10	109	106	26	60-69	

## References

1. Cochlin D, Megahan J, Goldberg B. Urinary tract, Diagnostic ultrasound a logical approach. Philadelphia: Lippincott – Raven; 1998.
2. Bircan O, Oner G, Saka O, Ravasoglu T, Akaydin M. The estimation of kidney sizes in Turkish Population. JIAS; 6(3): 1-5.
3. Brandt TD, Neiman HL, Dragowski MJ, Bulawa W, Claykamp G. Ultrasound measurement of normal renal dimensions. J Ultrasound Med 1982;1 (2): 49-52.
4. Emamian SA, Nielsen MB, Pedersen JF. Intraobserver and interobserver variations in sonographic measurements of kidney size in adult volunteers: A comparison of linear measurements and volumetric estimates. Acta Radiol 1995; 36(4): 399-401.

5. Emamian SA, Nielsen MB, Pedersen JF, Yette L. Kidney dimensions at sonography: correlation with age, sex, and habitus in 665 adult volunteers. *Am J Roentgenol* 1993;160 (1): 83.
6. Wald H. The weight of normal adult human kidneys and its variability. *Arch Pathol* 1937; 23 (3): 493.
7. Ablett MJ, Coulthard A, Lee RE, Richardson DL, Bellas T, Owen JP, et al. How reliable are ultrasound measurements of renal length in adults? *Br J Radiol* 1995; 68(814): 1087-9.
8. Emamian SA, Nielsen MB, Pedersen JF. Tenth percentiles of kidney length in adult volunteers . *Am J Roentgenol* 1994; 163(1): 748.
9. Karn MN. Radiographic measurements of kidney section area. *Ann Hum Genet* 1962; 25(4): 379.
10. Miletic D, Fuckar Z, Sustic A, Mozetic V, Stimac D, Zauhar G. Sonographic measurements of absolute and relative renal length in adults. *J Clin Ultrasound* 1998; 26(4): 185-9.
11. Thurston W, Wilson ST. The urinary tract. In: Rumack CA, Wilson ST, Charboneau J. *Diagnostic ultrasound*. Philadelphia: Mosby; 1998. p. 329-397.
12. Spiegl G, Jeanty P, Kittel F. Ultrasonic measure of the normal kidney. *J Belge Radiol* 1982; 65 (6): 513.
13. De Sanctis JT, Connolly SA, Bramson RT. Effect of patient position on sonographically measured Renal length in neonates, infants and children. *Am J Radiol* 1998; 170 (5): 1381-3.
14. Edell SL, Kurtz AB, Rifkin MD. Normal renal ultrasound measurements. *Atlas of ultrasound Measurements*. Chicago: Year Book; 1990.

Archive of SID