Sonographic Measurement of Renal Size in Normal Indian Children

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Objectives: To determine the renal size in normal Indian children by sonography.

Settings: Pediatric teaching hospital, Mumbai, India.

Duration: 1.5 years.

Design: Cross-sectional observational study.

Participants: 1000 normal Indian children aged 1 month - 12 years.

Methods: Sonographic assessment of renal size (length, width and thickness) was performed using Philips real time mechanical sector scanner of 3.5-5 MHz frequency with electronic caliper. The mean renal dimensions and volume were calculated for each age group with ± 2SD. The renal length and calculated renal volume were correlated with somatic parameters like age, weight, height and body surface area. Regression equations were derived for each pair of dependent and independent variables.

Results: No statistical difference was found in renal size between sexes and between right and left kidney. A strong correlation was seen between renal size with various somatic parameters, the best correlation was between renal size length and body height (coefficient of correlation=0.9).

Conclusion: This study provides values of renal length (mean ± 2SD) in normal Indian children. Renal length can be easily calculated by derived linear regression equation.

Key words: *Anthropometry, India, Kidney, Size, Ultrasonography*.

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The assessment of renal size is an integral part of evaluation of renal diseases for both diagnostic and prognostic purposes. Sonography is a non-invasive modality for measuring renal size. Data on normal renal size are available from western population [1-3]. Indian data regarding renal size and its correlation with other somatic parameters in normal Indian children are based on studies with a small sample size and sparse age distribution [4-9]. The present study was undertaken to determine renal size in normal Indian children (1 month-12 years).

METHODS

Normal children aged 1 month and 12 years were eligible for inclusion in the study. The children were either healthy siblings of patients attending the out-patient clinics or those visiting well-baby clinics. Consent was obtained from the accompanying parents. Children suffering from any acute or chronic ailment were excluded from the study. Age, weight and height were recorded at the time of the examination. Infants were weighed on an infant weighing scale and older children on a beam balance. Weights were recorded to the nearest 100 gms. The supine lengths were measured on an infantometer in children below 2 years and the standing height was measured on a stadiometer in children above 2 years to the nearest 1 mm. One investigator took all the measurements. The body surface area (BSA) was calculated from weight [10].

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A Philips real-time mechanical sector scanner of 3.5-5 MHZ frequency with electronic calipers was used to measure the length, width and thickness of each kidney with the child placed in a supine oblique position. The maximal renal length was recorded after re-positioning the probe in several angulations. Renal width was measured at renal hilum and thickness was recorded from transverse scans showing the maximum dimension. All the measurements were made by one investigator. The mean of right and left kidney measurements was used in all calculations. The renal volume was calculated by the formula [1]:Volume = 0.5233 × length × width × breadth.

The mean length, width and volume ±2 SD of the right and left kidneys were calculated separately for age groups of 1 month, 3 months, 6 months, 9 months, 1 year, and every year thereafter throughout 12 years. Length and volume were the two (dependant) variables of renal size considered for correlating with somatic parameters. Regression equations and coefficients of correlation were derived for each pair of variables. The statistical difference among the groups was determined by t test. Coefficient of correlation was derived by Pearson coefficient of correlation. Statistical analysis was performed using SPSS software.

Results

There were 1000 children (480 females) in 16 age groups from 1 month to 12 years of age. The number of children within each age group ranged from 35 to 120 with a mean of 77 children. The mean renal length (SD) increased steadily with age from 4.3 (0.6) cm at 1 month to 8.6 (0.8) cm at 12 years of age. The mean renal volume (SD) increased from 9.7 (4.4) mL at 1 month to 61 (17) mL at 12 years (***Table* I**).

There was a good correlation of renal size with age, body weight, body height and BSA The best correlation was of renal length with the body height (r=0.9) and body surface area (r=0.89). Renal volume also had good correlation with body height in cms (r=0.85). ***Fig*.1** shows scatter diagrams of mean renal length with body height and age, respectively. Linear regression equations for predicting variable (renal length) from independent variables (age and height) were obtained as follows: Renal Length = 0.0421 × height + 2.6311; and Renal Length = 0.3055 × age + 5.2533.

Discussion

In the present study the renal size correlated well with most commonly used parameters of overall body size including age, body weight, body height and body surface area. The best correlation of renal size was seen with body length and body surface area. While the renal volume correlated best with body surface area.

Although body proportion and rate of general somatic growth are strikingly different between boys and girls, their renal lengths did not display a significant difference. Other studies have also reported similar observations [1, 3, 9-11]. A number of studies have assessed renal size and volume in children and have correlated to somatic parameters. As with our findings with respect to correlation, other studies have revealed similar results [6-11]. In children with growth failure and under-nourished children, it will be better to correlate the renal length with the body length [14]. Judged by sonography, the renal length in Indian children was lower by 11-20% as compared to American children with respect to age, probably due to the larger body size of their American counterparts [2]. Had we compared with body height, the

TABLE I Mean Renal Length and Volume of Study Children (N=1000)

Age	*Weight (kg) Mean (SD)*	*Height (cm) Mean (SD)*	*Body surface area (m^2) (SD)*	*Renal length (cm) Mean (SD)*	*Renal volume (mL) Mean (SD)*
1 mo (*n*=71)	2.5 (0.4)	48.5 (2.1)	0.18 (0.02)	4.3 (0.6)	9.7 (4.7)
3 mo (*n*=49)	3.7 (0.9)	53.8 (4.2)	0.23 (0.05)	4.7 (0.7)	12.1 (6.0)
6 mo (*n*=61)	5.6 (1.1)	61.8 (4.4)	0.32 (0.05)	5.5 (0.7)	18.3 (7.0)
9 mo (*n*=81)	7.3 (0.9)	68.5 (3.7)	0.39 (0.03)	5.6 (0.6)	19.6 (6.8)
1 y (*n*=122)	8.5 (1.1)	72.0 (2.8)	0.44 (0.04)	5.7 (0.4)	21.3 (5.5)
2 y (*n*=75)	9.7 (1.4)	79.0 (7.6)	0.48 (0.05)	6.1 (0.7)	25.3 (8.2)
3 y (*n*=58)	11.2 (1.5)	89.2 (5.0)	0.54 (0.05)	6.7 (0.6)	31.3 (10.0)
4 y (*n*=63)	12.9 (1.0)	95.7 (4.2)	0.59 (0.03)	6.8 (0.60)	32.9 (9.1)
5 y (*n*=66)	14.0 (1.7)	101.1 (4.3)	0.62 (0.05)	6.7 (0.6)	33.0 (8.9)
6 y (*n=54*)	16.5 (2.2)	107.5 (5.2)	0.69 (0.06)	6.7 (0.4)	34.2 (9.4)
7 y (*n=48*)	18.0 (2.1)	112.5 (5.5)	0.74 (0.06)	7.2 (0.6)	44.6 (12.7)
8 y (*n=57*)	20.6 (2.2)	116.8 (6.0)	0.81 (0.05)	7.6 (0.7)	49.8 (14.8)
9 y (*n=58*)	24.0 (2.7)	125.8 (4.1)	0.88 (0.06)	8.0 (0.6)	56.2 (16.7)
10 y (*n=43*)	25.9 (3.9)	130.4 (5.8)	0.92 (0.08)	8.0 (0.7)	58.0 (16.2)
11 y (*n=32*)	30.9 (4.3)	138.9 (5.3)	1.02 (0.09)	8.5 (0.8)	59.8 (17.3)
12 y (*n=62*)	31.9 (4.5)	141.7 (5.8)	1.04 (0.09)	8.6 (0.8)	61.4 (16.5)

**SD: standard deviation; mo= months; y=year.*

WHAT IS ALREADY KNOWN?

- Sonography-based renal size in Western population groups.

WHAT THIS STUDY ADDS?

- Sonography-based renal size in normal Indian children aged 1 month-12 years and linear regression equation to predict renal size from length/height of children.

difference may have been less. Comparison of renal volume and BSA of Indian children with those of American children may have shown less difference.

There are numerous advantages of ultrasonography in determining renal size. They include the lack of ionizing radiation exposure, radiographic magnification and osmotic effect of the iodinated contrast material [2]. The examination is real time, tridimensional, independent of organ function and phase of respiration. Previously the kidney size was accurately measured on intra venous urography which had its own disadvantages [15-17]. Although the renal length correlated best with body height and body surface area, the calculation of body surface area is cumbersome and requires multiple measurements. In clinical practice, the body height can be quickly recorded to compare the actual renal length with the renal norm. Similarly, since the estimation of renal volume requires measurement of three dimensions of the kidney, the error associated with renal volume increases in geometric proportion. Hence it is simpler to use renal length as a yardstick for comparing renal growth with body growth. Due to the large sample size, this study represents the population more closely. However, the socioeconomic status of children examined was not recorded, although they typically belonged to lower middle and lower income group. Considering the large population of India, the study did not consider parameters such as race, culture, income group, rural or urban origin.

The renal size norms developed by this study provide normal kidney length range for children according to age and body size.

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REFERENCES

1. Han BK, Babcock DS. Sonographic measurements and appearance of normal kidneys in children. AJR Am J Roentgenol. 1985;145:611-6.
2. Rosenbaum DM, Korngold E, Teele RL. Sonographic assessment of renal length in normal children. Am J Radiol. 1984;142:467-9.
3. Haugstvedt S, Lundberg J. Kidney size in normal children measured by sonography. Scand J Urol Nephrol. 1980;14:251-5.
4. Mehta KP, Karnik SR, Sathe A, Pant R, Khatwan R, Bhise A. Renal parameters during infancy. Indian Pediatr. 1992;29:1385-90.
5. Gupta AK, Anand MK, Lamba IS. Ultrasound evaluation of kidney dimensions in neonates. Indian Pediatr. 1993;30:319-24.
6. Dixit PK, Sahai SB, Rath B, Garg A, Chowdhary V. Norms for renal parenchymal volume in Indian children.

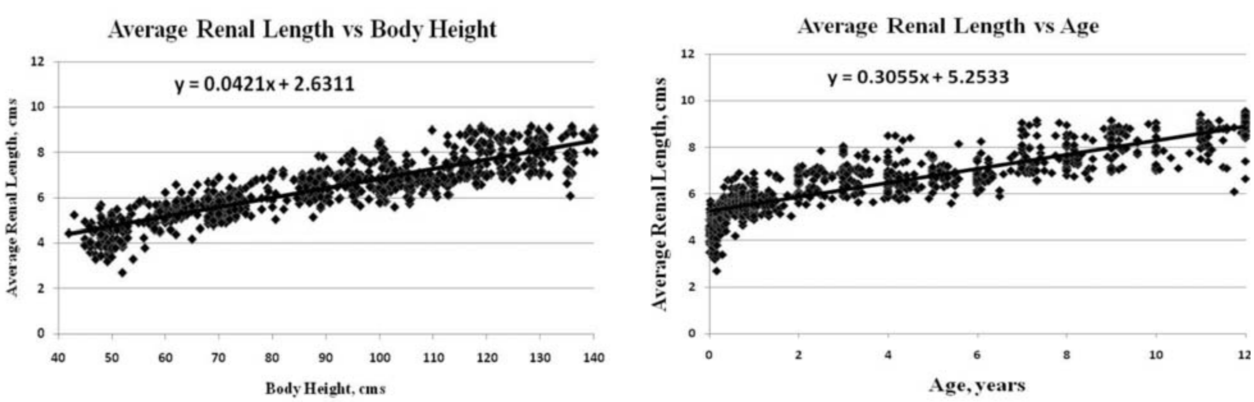

FIG. 1 *Regression equation of* (*i*) *renal length vs body height* (*ii*) *renal length vs age*.

Indian Pediatr. 1994;31:1059-64.

7. Mathur S, Chandra J, Mittal KP, Mittal SK, Khurana A. Sonographic assessment of renal length in Indian children. Indian J Pediatr. 1996;63:553-60.
8. Chattopadhyay P, Bhatnagar V, Gupta AK, Mitra DK. Ultrasonography assessment of renal growth in normal Indian children. Indian J Urol. 1998;14:22-5.
9. Ganesh R, Vasanthi T, Lalitha J, Rajkumar J, Muralinath S. Correlation of renal length with somatic variables in Indian children. Indian J Pediatr. 2010;77:326-8.
10. Vaughan VC III, Iris LF. Growth and development. *In*: Behrman, Kliegman, Nelson, Vaughan, editors. Nelson Textbook of pediatrics. 14th ed. WB Saunders Company Harcourt Brace Jovonovich Inc : 1992. p. 40.
11. Schlesinger AE, Hernandez RJ, Zerin JM, Marks TI, Kelsch RC. Interobserver and intraobserver variations in sonographic renal length measurements in children. Am J Radiol. 1991:156:1029-32.
12. Ece A, Gozu A, Bukte Y, Tutanc M, Kocamaz H. The effect of malnutrition on kidney size in children. Pediatr Nephrol. 2007;22:857-65
13. Currarino G. Roentgenographic estimation of kidney size in normal individuals with emphasis on children. Am J Radiol. 1965;93:464-6.
14. Ekf O, Ringertz H. Kidney size in children: a method of assessment. Acta Radiol Diagn (Stockh). 1976;17:617-25.
15. Hodson CJ, Drewe JA, Karn MN, King A. Renal size in normal children: a radiographic study during life. Arch Dis Child. 1962;37:616-22.