NORMS FOR RENAL PARENCHYMAL VOLUME IN INDIAN CHILDREN

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ABSTRACT

Seventy-seven clinically normal children with kidneys of normal size were examined sonographically. Renal parenchymal volumes were calculated and related to age, height, body weight and body surface area; growth charts were constructed. A significant correlation was found between the renal parenchymal volume and the body somatometric parameters. The present report thus provides norms for renal parenchymal volume in Indian children.

Key words: *Ultrasonography, Renal volume.*

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Renal disease, especially Urinary Tract Infection (UTI), often causes morphological as well as morphometric changes in the kidney which could be temporary or permanent according to the etiopathogenesis of the primary disease(l-3). Since, it is generally agreed that normal renal parameters correspond to, somatic parameters, it is imperative that physiological kidney growth in children be studied in detail(l,2). Normal values thus determined serve as a baseline to study renal growth and detect an abnormality with a greater degree of confidence.

Renal size can be determined on urography by measuring the renal length(4), area(5,6) and parenchymal thickness(7). Kidney length and volume can also be determined using ultrasonography and have been correlated to somatic parameters in a number of past studies(8-10). Sonographically the kidney is seen to consist of a central highly echogenic core called the renal sinus surrounded by a comparatively less echogenic lawyer called the renal parenchyma. The central echo complex (or the renal sinus) includes the renal collecting systems, calyces, renal infundibula, arteries, veins, lymphatics, peripelvic fat and part of the renal pelvis. The renal parenchyma consists of the cortex and medulla. The total renal volume includes both the renal sinus and the renal parenchyma. An accurate assessment of the renal parenchymal volume (RPV) can be made by excluding the volume of the renal sinus from the total renal volume. Traditionally we have been relying on western standards since no studies on Indian children are available for assessing the normal renal parenchymal volume in correlation with somatic parameters. The present sonographic study reports the Indian norms in this context.

Material and Methods

A total number of 77 clinically healthy children (46 males and 31 females), aged 1-12 years were included in this study. These subjects were referred from the Well Baby Clinic, Immunization Clinic and the Pediatric OPD for acute onset diseases other than that of the urinary tract. Diabetics and children with chronic systemic diseases were excluded. An informed parental consent was obtained in each case. The age in years, sex, body length from crown to heel in cm and body weight in kg (sensitivity 100 g) were noted. Body surface area was calculated using the formulae(11) depicted in *Table I.*

The patients required no prior preparation. All the ultrasound (US) examinations and measurements were performed using SIEMENS-SONOLINE SL-2 Real Time Mechanical Sector scanner of 3.5 MHZ and 7.5 MHZ frequencies equipped with electronic calipers. The child was placed on the couch in the supine and supine-oblique positions and preliminary scans performed in longitudinal and transverse axes to rule out renal structural abnormalities. The child was then placed in the prone position and a roll-like pillow placed below the upper abdomen in order to compensate the lumbar lordosis. The transducer was then placed in the renal angle parallel to the spine and moved laterally. Once the kidney was located, the transducer was rotated slightly to determine the longest renal axis. The longitudinal image of the kidney frozen for measurement was that which appeared longest and showed the central sinus echoes the best with the renal parenchyma evenly distributed all around the central sinus. The transducer was then rotated 90 degrees to the longitudinal axis and the transverse section was obtained at the level of the renal hilum. Electronic calipers were used to measure the renal morphometric parameters. Maximum renal depth (D), length (L) and width (W) and the maximum length (1), depth (d) and width (w) of the echogenic central sinus were measured in cm.

TABLE I–*Formulae for Calculating Body Surface Area (BSA)*

Weight range (kg)	Surface area (m^2)
1 to 5	$(0.05 \times kg) + 0.05$
6 to 10	$(0.04 \times kg) + 0.10$
11 to 20	$(0.03 \times kg) + 0.20$
21 to 40	$(0.00 \times kg) + 0.40$

The volume of the entire kidney and that of the central sinus echoes were calculated using the prolate ellipsoid formula(9).

$$V\,(ml) = L \times W \times \frac{D1 + D2}{2} \times 0.523$$

where Dl = maximum depth in longitudinal section.

D2 = maximum depth in transverse section.

The renal parenchymal volume was calculated by subtracting the renal sinus volume from the renal volume. Renal parenchymal volume for children less than 1 year of age was not calculated to avoid error due to paucity of renal sinus fat in that age group(12).

The mean and standard deviation of renal parenchymal volume were calculated for right and left sides and either sex. The statistical significance of the difference was assessed by the ANOVA test. Pearsons correlation co-efficient with 95% confidence limits, regression equations and standard deviation were calculated for renal parenchymal volume versus each somatometric parameter. Renal growth charts were thus established.

Results

The kidney volumes for right and left sides as well as for males and females were comparable ($p>0.05$); the data was therefore pooled. The results of the correlation of somatometric parameters with renal parenchymal volume are presented in *Table II.*

The derived growth charts are shown in *Figs. 1-4.* It is obvious that the renal parameters show a significant increase with rise in age, body length, body weight and body surface area.

Discussion

In most studies in the past, the renal length and renal volume have included the measurement of the renal sinus echoes along with the surrounding parenchyma.

TABLE II-*Correlation of Renal Parenchymal Volume (RPV) with Somatomertric Parameters*

S.No.	Somatometric parameters	Correlation coefficient		Regression equation
		r	r	
1	Age (yrs)	0.86	0.74	y= 13.27 + 3.52x
2	Body length (cm)	0.91	0.82	y= 0.57 x - 25.85
3	Body weight (kg)	0.88	0.77	y= 9.54 + 1.58x
4	Body surface area (cm2)	0.98	0.84	y= 0.0O65x - 9.26

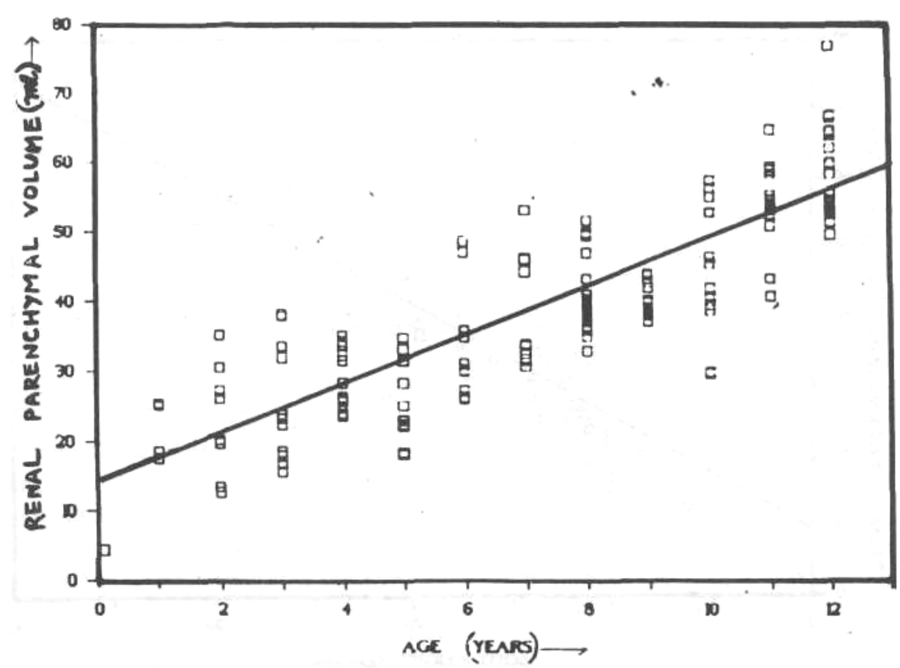

Fig. 1. Correlation between renal parenchymal volume and age.

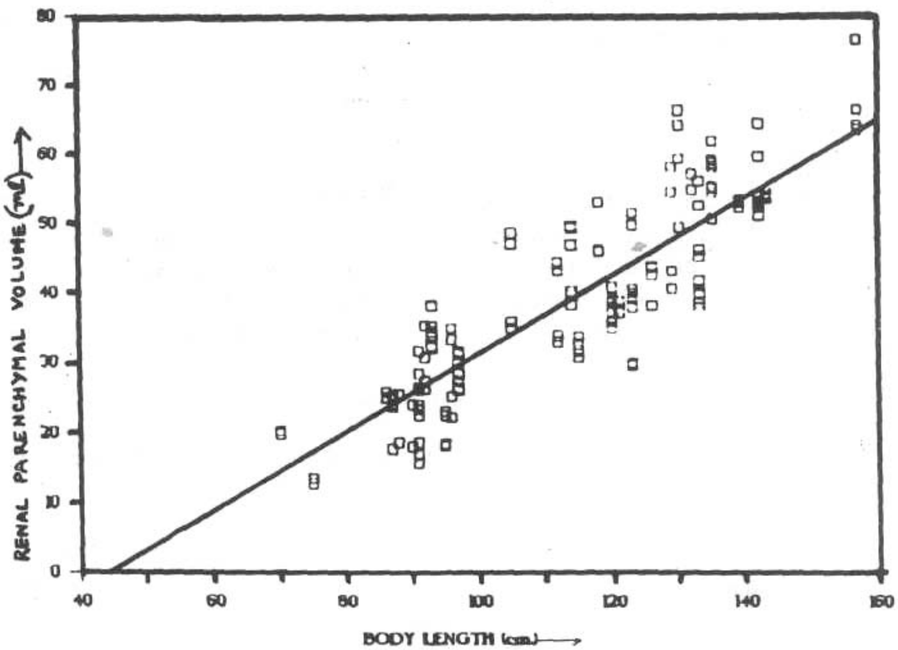

Fig. 2. Correlation between renal parenchymal volume and body length.

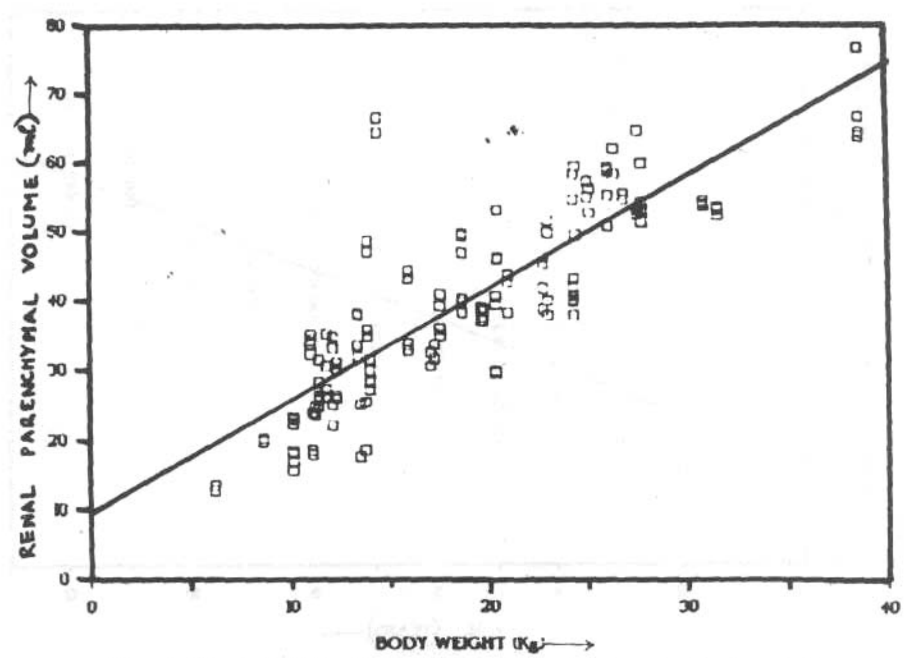

Fig. 3. Correlation between renal parenchymal volume and body weight.

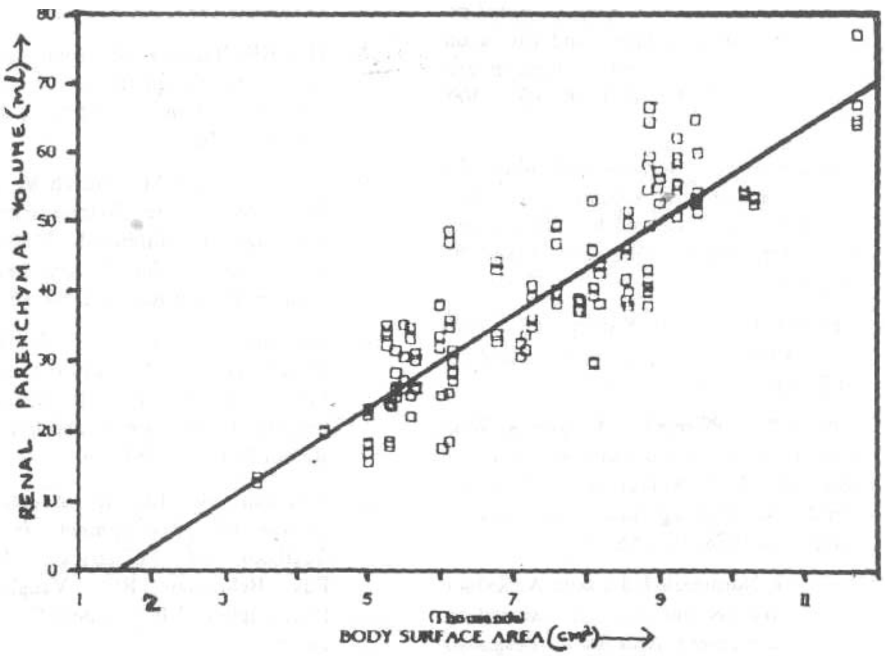

Fig. 4. Correlation between renal parenchymal volume and body surface area.

However, the renal sinus which represents mainly the collecting system alongwith its surrounding fat may be abnormal in size and shape giving rise to false abnormalities in overall renal length and volume. The present study documents the normal parameters for renal parenchymal volume in Indian children after excluding the volume of the central renal sinus echoes.

In contrast to a number of previous mall studies(3,4,9), the differences between right and left kidneys and between males and females were statistically insignificant. In practice, it is therefore, not necessary to use different parameters for the right and left sides or in males and females.

In the present study RPV was correlated with somatometric parameters such as age, body length, body weight and body surface area. In contrast, in some previous studies only body weight and body surface area have been used(3,9). However, it is believed that in normal sized, healthy children all the four somatometric parameters used in this study have a fairly steady and direct relationship with each other making them all applicable in the present study.

The regression equations established in this study can be used for direct calculation of the mean RPV when only one or multiple somatometric parameters are known, for use in renal disorders in children.

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