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Original Research Article

Sonographic measurement of renal size in normal North Indian children

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Abstract

Objective: To determine the renal size in normal North Indian children by renal sonography.
Design: Hospital based (outpatient based) cross sectional observational study.
Material and methods: Total 1198 normal children aged 1 month to 12 years were included in the study. Sonographic assessment of renal size (length, width and thickness) was performed using Philips, multi frequency (3.5, 5 and 7.5 Mhz) linear and convex probes in B-mode. 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 (BSA). Linear Regression equations were derived for each variable.
Results: A strong correlation was seen between renal size and renal volume with various somatic parameters (age, weight, height, BSA), (coefficient of correlation = 0.9).
Conclusion: This study provides values of renal size (mean ± 2SD) in normal North Indian children and its correlation with age, weight, height, and BSA. Renal size can be easily calculated by derived linear regression equation.

Key words

Somatic parameter, Kashmiri, Kidney, Size, Sonography.

Introduction

Renal size is an important parameter in the assessment of a child with renal disease. Decrease or increase in kidney size is an important sign of renal disease [1]. Renal size can be estimated by measuring renal length, renal thickness and volume. Since the change in renal length may be an evidence of disease, it is

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important that we have normal reference values in children in relation to their age, gender, height, weight, body surface area and ethnicity. Age related nomograms are most commonly used to interpret normal renal length. However these nomograms are based on a healthy Western population, while as only few studies are from Indian subcontinent, needs a more research to settle the knowledge gap. Hence it would be useful to develop our own nomograms for our children using an adequate sample size.

Material and methods

All normal healthy siblings of patients attending the out-patient clinics, and those visiting vaccination center aged 1 month to 12 years were included in study. Age, weight, and height were recorded at the time of the examination. After taking proper consent from parents, infants were weighed on an infant weighing scale and older children on beam balance. Weights were recorded to the nearest 100 gm. 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. The body surface area (BSA) was calculated from weight [2].

A Philips real-time mechanical sector scanner of 3.5, 5, and 7.5 Mhz frequency with electronic calipers was used to measure the length, width and thickness of each kidney with the child placed in a supine and 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 renal volume was calculated by the formula: Volume = 0.5233 × length × width × breadth [3]. The mean length, width and volume ±2 SD of the right and left kidneys were calculated separately for age group.

Statistical analysis

Regression equations and coefficient of correlation were derived for each pair of variables. Coefficient of correlation was derived by Pearson coefficient of correlation. Analysis was performed using SPSS 17.0 software. Continuous variables were presented as mean ± SD and categorical variables were presented as absolute numbers and percentage. Normally distributed continuous variables were compared using un paired 't' test. Linear regression analysis was done using kidney size and kidney volume as dependent variables and age, height, weight, and BSA as the independent variables. P value <0.05 was taken as significant.

Exclusion criteria

Children suffering from any acute or chronic ailment, any metabolic or chromosomal abnormality, or apparent syndromic child, and those below the age of 1 month, were excluded from study.

Results

The study was done over 1198 normal children aged from 1 month to 12 years in 16 age groups. 51% (618) males and 49% (580) were females. The average kidney size ranged from mean size of 4.42 ± 0.11 cm in 1 month to 8.72 ± 0.13 cm in 12 years old children. The average kidney volume measured by ultrasonography ranged from mean 9.37 ± 0.66 ml at 1 month to 59.37 ±2.09 ml at 12 years as per **Table – 1**.

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 = 0.978) and (r = 0.98) in females and males respectively and body surface area (r = 0.979) and (r = 0.97) in females and males respectively.

Renal volume also had good correlation with body height in cm (r = 0.97) and (r = 0.97) in females and males respectively and body surface area (r = 0.96) and (r = 0.96) in females and males respectively.

Linear regression equations for predicting variable (renal length and renal volume) from independent variables (age, height, weight and BSA) were obtained as per **Table - 2** and **Table - 3**.

Discussion

The purpose of our study was to see renal parameters (length, breadth, width and volume) by sonography in normal Kashmiri children and compare with various somatic variables (age, weight, height, body mass index, and body surface area).

There was significant correlation of renal size with age, body weight, Height, BSA in our study particularly more with height and BSA. Other studies have revealed similar results [4, 5, 6, 7].

There was a good correlation between kidney volume with age, body weight, Height and BSA particularly more with height and BSA. Other studies have revealed similar results [4, 8].

Renal lengths did not display a significant difference in males and females as per **Table - 4**. Other studies have also reported similar observations [5, 9, 10].

Sonography has become an important part of the pediatric imaging armamentarium, perhaps the most important. Its strengths are many, to begin, it does not use ionizing radiation, does not require administration of intravenous contrast agents, although several ultrasound contrast agents have been recently developed that can increase the accuracy of the imaging examination, does not require sedation, and is easily available and reproducible [11].

Conclusion

In clinical practice, the body height and weight can be quickly recorded to compare the actual renal length with the renal norm. 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.

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

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Table – 1: Mean renal length and volume of study children. (n = 1198)

Age groups	WT (Kg)	HT (cm)	BSA (m^2)	avg_kidney size(cm)	avg_WD (cm)	avg_BD (cm)	avg_VL (cm^3)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
1-3month	3.40 ± 0.11	49.88 ± 1.28	0.21 ± 0.00	4.42 ± 0.11	2.20 ± 0.06	1.87 ± 0.13	9.37 ± 0.66
3-6 months	4.89 ± 0.24	54.43 ± 2.33	0.27 ± 0.01	4.42 ± 0.07	2.29 ± 0.09	2.13 ± 0.09	11.24 ± 0.75
6 - 9months	6.19 ± 0.27	63.13 ± 4.43	0.32 ± 0.01	5.6 ± 0.10	2.47 ± 0.12	2.34 ± 0.17	16.97 ± 1.04
9-12 months	7.72 ± 0.29	66.33 ± 4.14	0.38 ± 0.01	5.61 ± 0.13	2.63 ± 0.12	2.62 ± 0.06	20.13 ± 0.96
1 - 2 yr	8.79 ± 0.23	72.37 ± 2.66	0.42 ± 0.01	5.68 ± 0.11	2.32 ± 0.09	2.77 ± 0.11	21.79 ± 1.14
2 - 3 yrs	10.61 ± 0.50	80.57 ± 2.14	0.49 ± 0.02	6.12 ± 0.16	2.81 ± 0.10	2.96 ± 0.06	26.57 ± 1.61
3 - 4 yrs	11.76 ± 0.45	88.71 ± 3.64	0.52 ± 0.01	6.44 ± 0.11	2.93 ± 0.04	3.13 ± 0.06	28.77 ± 1.24
4 - 5 yrs	13.24 ± 0.53	95.44 ± 3.22	0.57 ± 0.02	6.74 ± 0.14	3.03 ± 0.09	3.24 ± 0.05	34.69 ± 1.20
5 - 6 yrs	14.60 ± 0.40	102.71 ± 4.49	0.62 ± 0.01	6.78 ± 0.08	3.09 ± 0.08	3.31 ± 0.04	34.11 ± 1.56
6 - 7 yrs	16.77 ± 0.95	109.14 ± 5.60	0.69 ± 0.03	6.83 ± 0.06	3.15 ± 0.05	3.33 ± 0.06	36.29 ± 0.73
7 - 8 yrs	18.41 ± 0.97	111.88 ± 3.20	0.74 ± 0.03	7.27 ± 0.11	3.22 ± 0.08	3.41 ± 0.10	41.70 ± 1.82
8 - 9 yrs	20.91 ± 0.73	117.75 ± 3.09	0.81 ± 0.02	7.59 ± 0.06	3.31 ± 0.13	3.50 ± 0.09	45.87 ± 2.54
9-10 years	24.14 ± 1.03	127.14 ± 1.56	0.90 ± 0.03	8.01 ± 0.07	3.46 ± 0.10	3.71 ± 0.07	53.58 ± 2.54
10-11 years	26.62 ± 0.82	130.62 ± 3.48	0.97 ± 0.02	8.09 ± 0.13	3.51 ± 0.13	3.72 ± 0.06	55.19 ± 3.31
11-12 years	30.69 ± 2.06	138.00 ± 2.93	1.07 ± 0.05	8.46 ± 0.11	3.40 ± 0.15	3.75 ± 0.13	55.92 ± 1.88
12 years	32.73 ± 1.72	142.29 ± 4.09	1.07 ± 0.04	8.72 ± 0.13	3.40 ± 0.13	3.82 ± 0.04	59.37 ± 2.09

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Table - 2: Depicts the correlation of kidney size with anthropometric variables and predicted regression equations.

Variable	R	r Square	P value	Predicted Equation
FEMALE				
Age	0.962	0.926	<0.001	5.157 + 0.301×Age
Weight	0.968	0.937	<0.001	4.464 + 0.145×Wt
Height	0.978	0.957	<0.001	2.618 + 0.043×Ht
BSA	0.979	0.958	<0.001	3.771 + 4.668×BSA
MALE				
Age	0.955	0.912	<0.001	5.142 + 0.314×Age
Weight	0.958	0.918	<0.001	4.520 + 0.135×Wt
Height	0.980	0.961	<0.001	2.453 + 0.043×Ht
BSA	0.972	0.945	<0.001	3.820 + 4.463×BSA

Table - 3: Depicts the correlation of kidney size with anthropometric variables and predicted regression equations.

Variable	R	r Square	P value	Predicted Equation
FEMALE				
Age	0.979	0.959	<0.001	15.158 + 3.751×Age
Weight	0.980	0.961	<0.001	6.667 + 1.791×Wt
Height	0.989	0.978	<0.001	(-)16.128 + 0.527×Ht
BSA	0.988	0.977	<0.001	(-)1.831 + 57.664×BSA
MALE				
Age	0.978	0.957	<0.001	15.117 + 4.031×Age
Weight	0.971	0.943	<0.001	7.412 + 1.173×Wt
Height	0.983	0.965	<0.001	(-)18.271 + 0.539×Ht
BSA	0.982	0.965	<0.001	(-)1.382 + 56.604×BSA

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Table - 4: Depicts the difference in males and females in renal lengths.

	Female		Male		P value
	Mean	Std. Deviation	Mean	Std. Deviation	
avg_kidneysize	6.68	1.23	6.69	1.30	0.849
avg_WD	2.92	0.42	2.97	0.47	0.054
avg_BD	3.12	0.56	3.11	0.58	0.758
avg_VL	34.08	15.02	35.04	16.37	0.291