Sonographic Measurement of Normal Kidney Dimensions among Sudanese Children

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Abstract

This study was conducted in Khartoum state, in the ultrasound department of Sheikh Khalid medical complex. The objective is to determine sonographically the normal limits of the kidney dimensions according to age, gender and somatometric parameters among Sudanese children who have morphologically normal kidneys. A prospective cross-sectional research design and convenience sampling method were utilized. Participants included 300 normal subjects (173 boys and 127 girls) their age ranged from 6 month – 14 years old. The Sonographic examination was performed on (Aloka SSD-4000 and Mindray DP-1100 machine) with 3.5 MHz convex transducer. The result showed that the dimensions of the kidneys were not statistically different in boys and girls ($p > 0.05$). There was a statistically significant difference between right and left kidney length ($p < 0.05$). Height and weight correlated best with both kidney lengths. Thus the normal limits, prediction models of kidney lengths were established with respect to height and weight. The study concluded that Sonographic determination of pathologic changes in the size of the kidneys necessitates knowing the normal ranges of their lengths, especially with respect to height in this population.

المستخلص

أجريت هذه الدراسة بولاية الخرطوم في قسم الموجات فوق الصوتية بمجمع الشيخ خالد الطبي . وتهدف الدراسة الي تحديد الابعاد الطبيعية للكلي عبر استخدام الموجات فوق الصوتية حسب العمر والجنس والمعايير الجسدية بين الأطفال السودانيين الذين لديهم كلي طبيعية شكليا. تم استخدام تصميم بحثي مستقبلي لطريقة أخذ العينات الملائمة . شملت الدراسة عدد 300 طفل منهم 173 طفل ذكر و127 أنثي تتراوح أعمارهم بين (6أشهر إلي 14 سنة), تم إجراء الفحص بالموجات فوق الصوتية بإستخدام أجهزة Aloka PHD . Prosound SSD-4000 و Mindray DP-1100 .

أظهرت النتائج أن أبعاد الكليتين لم تكن مختلفة عند الأولاد والبنات ($p> 0.05$) كان هناك فرق ذو دلالة إحصائية بين طول الكلي اليمني واليسري ($p> 0.05$). يرتبط الطول والوزن بشكل أفضل مع أطوال الكلي وهكذا تم تحديد الأبعاد الطبيعية ونماذج التنبوء لأطوال الكلي فيما يتعلق بالطول والوزن . وخلصت الدراسة إلي تحديد التصوير بالموجات فوق الصوتية للتغييرات المرضية في حجم الكلي والذي يتطلب معرفة النطاقات الطبيعية لأطوالها خاصة ما يتعلق بالطول في هذه المجموعة المختارة من الطلاب لذلك تم إستبعاد كل الحالات غير الطبيعية أو المرضية

Introduction

Measurement of kidney size is an important issue because many disorders can increase or decrease kidney size. Serial volume measurements can be used to track the normal growth pattern of kidneys and to follow the known pathology of kidney in children. Several methods have been used for measuring renal sizes, including abdominal CT and MRI. However, these imaging modalities have disadvantages such as radiation exposures and high costs as well as sedation may be used in case of pediatric imaging. There were significant correlations between all renal dimensions with age, weight, height, In the regression analysis, the most significant contributing factor to renal growth was height , there was statistically significant differences were observed between right and left kidneys length and volume but there is no significant difference between other kidney measurements(width and breadth).also the study found that was no significant difference in the kidney length and volume among boys and girls in all age groups. Scatter plots were created, and they showed a close linear relationship between height and renal length and renal volume. Renal size is an important parameter in the assessment of a child with renal disease since the kidney continues to grow in size after birth and reaches the near adult size of 10 cm by 12 years of age decrease or increase in kidney size is an important sign of renal disease. Thus while evaluating a child presenting for the first time with a sudden deterioration of renal functions; it is the kidney size which helps differentiate acute kidney injury where the size maybe normal or large, from an acute exacerbation of chronic kidney disease (CKD) where the kidney size is invariably small.

Objective: To determine sonographically the normal limits of the kidney dimensions according to age, gender and somatometric parameters among Sudanese children who have morphologically normal kidneys.

Materials and Method: A prospective cross-sectional research design and convenience sampling method were utilized. Participants included 300 normal subjects (173 boys and 127 girls) their age ranged from 1 – 14 years old. The Sonographic examination was performed on (Aloka SSD-4000 and Mindray DP-1100 machine) with 3.5 MHz convex transducer. Longitudinal and transverse dimensions of the kidneys were obtained in coronal plane with the subject in the supine or left lateral decubitus position. The maximum renal length (L) (cm), orthogonal anterior-posterior diameter (D) (cm) and width (W) (cm) of each kidney were measured. Coronal indices including height (cm), weight (kg) and body mass index (BMI) were also collected.

Results: The means of right and left kidney lengths in cm were 8.33 ± 1.03 and 8.51 ± 1.05, respectively while those of the right and left kidney widths in cm were 3.29 ± 0.52 and 4.09 ± 0.62, respectively. Dimensions of the kidneys were not statistically different in boys and girls ($p > 0.05$). There was a statistically significant difference between right and left kidney length ($p < 0.05$). Height and weight correlated best with both kidney lengths. Thus the normal limits, prediction models of kidney lengths were established with respect to height and weight.

Conclusion: Sonographic determination of pathologic changes in the size of the kidney necessitates knowing the normal ranges of its length especially with respect to height and weigh in children.

Keywords: Measurements, Renal size, Children, Sonography

1. Introduction:

Kidney size is an essential parameter for evaluating pediatric renal and genitourinary tract pathologies (Oswald et al., 2004). Measurement of its size is an important issue because many disorders can increase or decrease kidney size. Serial volume measurements can be used to track the normal growth pattern of kidneys and to follow the known pathology of kidney in children (Bax et al., 2003). The establishment of normal kidney values in routine imaging tests can serve as a baseline for the diagnosis of kidney disease associated with changes in size, such as acute or chronic pyelonephritis (Eze et al., 2014).

Several methods have been used for measuring renal sizes, including abdominal CT and MRI. However, these imaging modalities have disadvantages such as radiation exposures and high costs as well as sedation may be used in case of pediatric imaging (Kim et al., 2013). Sonography is a simple and reliable way to visualize and measure abdominal visceral organs without the risk of ionizing radiation. Sonographic measurement is non-invasive and does not have the problem of magnification but is less reproducible compared to urographic measurement (Roger et al., 1994). Refinements in ultrasound technology have advanced the use of this modality beyond the simple display of anatomy, anatomic relationships and spatial localization of lesions. Sonography is also useful in the determination of agenesis, hypertrophy, atrophy and ectopic location of the kidneys (Eze et al., 2014).

In cases of gross enlargement of the kidneys, confirmation by Sonography is easy. However, where there is only mild enlargement as a result of disease processes, making decision about the size can be difficult. Therefore, it is very important to have a set of standard normal Sonographic values showing upper and lower limits (Bakker et al., 1999). Prediction model of kidney size estimation according to the parameter that shows the best correlation with the kidney size is also important to be built as an alternative method for examiners in remote locations where ultrasound facility is not readily available. The aim of the present study is to determine the normal limits of the kidney dimensions in relation to age, gender, height and weight among healthy children in Sudanese population. The establishment of these data in the present study will enable a more practical and objective evaluation during a Sonographic examination involving the kidneys of children.

2. Materials and Method:

The study was conducted using a prospective cross-sectional research design and convenience sampling method at Elsheikh Khalid Medical Centre, Khartoum – Sudan. The sample group

included 300 children between one and 14 years. Some of the children recruited into the study attended hospital for clinical reasons unrelated to kidney and for routine medical examinations at the study center.

The apparently normal subjects were examined by a pediatrician and those who met the selection criteria were in-listed in the study. Subjects with acute or chronic renal failure, renal parenchymal mass lesion, cysts and hydro nephrosis were excluded. Apparently healthy subjects and subjects with normal sonographic appearances of the kidneys were included. Ethical approval was obtained from the ethics committee of the Sudan University of Science and Technology.

The Sonographic examinations were performed with high resolution real time scanners (Aloka SSD-4000 and Mindray DP-1100 machine) with 3.5 MHz convex transducer. Demographic data were collected from each participant at the time of their pre-participation physical examination. This information included age, gender, height and weight. Kidney size (length and width) measurements (Fig. 1) were obtained in the coronal plane passing through the renal hilum with the subjects in the supine or slightly right or left lateral decubitus positions. This technique was adopted because of the superior advantage of obtaining easily the longest dimension of the kidneys and reproducibility of measurements. Organ dimension was measured three times, and the mean values were recorded. All measured organs for normal subjects had normal position, shape and echotexture. The measurement of organ dimensions was made during deep inspiration.

Descriptive statistics were performed and the data were presented as minimum, maximum, mean and standard deviation. The association between kidney dimensions and gender, age, height and weight was assessed with Pearson's correlation coefficient; to determine the exact pattern of the relationship. Difference of continuous variables between two independent groups was assessed

with the Student's t-test. All statistical techniques were performed using SPSS statistical package version 20 (IBM SPSS Statistics, USA).

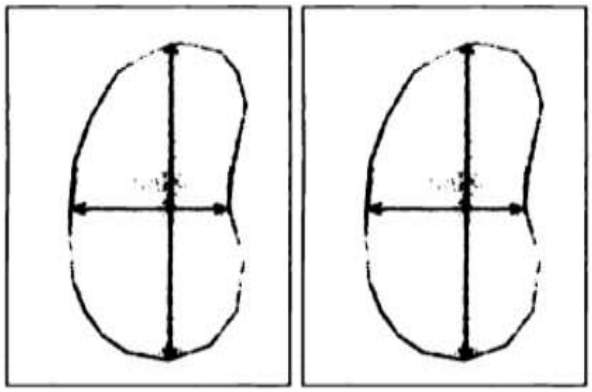

Figure (1): show longitudinal and transverse dimensions of kidney were measured in coronal section passing through renal helium

3. Results:

Table (1): descriptive statistic for age, height, weight, Right Kidney and left kidney length and width

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age (Yrs.)	300	1	14	9.36	3.12
Weight (Kg)	300	5	68	28.03	10.88
Height (cm)	300	59	168	130.88	20.42
BMI (Kg\cm^2)	300	9.69	36.00	15.77	3.16
RTK length	300	4.9	10.8	8.33	1.03
LTK length	300	4.9	11.7	8.51	1.05
RTK width	300	2.1	8.7	3.29	0.52
LTK width	300	2.3	7.4	4.09	0.62

Table (2): mean Right Kidney and left kidney length and width in different age group

Age		RTKL	LTKL	RTKW	LTKW
1 - 5	Mean	6.72	6.90	2.89	3.36
	Std. Deviation	.925	.95	.43	0.67
	Minimum	4.9	4.9	2.1	2.3
	Maximum	8.1	9.1	3.8	5.8
5 - 10	Mean	8.08	8.28	3.14	3.93
	Std. Deviation	.70	.71	.35	.53
	Minimum	6.2	6.4	2.5	2.9
	Maximum	9.6	10.3	4.8	7.4
10.- 14	Mean	9.00	9.15	3.54	4.43
	Std. Deviation	.75	.81	.57	.45
	Minimum	6.3	7.2	2.3	3.4
	Maximum	10.8	11.7	8.7	5.9
Total	Mean	8.33	8.51	3.29	4.09
	Std. Deviation	1.03	1.05	.52	.62
	Minimum	4.9	4.9	2.1	2.3
	Maximum	10.8	11.7	8.7	7.4

Table 4 mean of Right Kidney and left kidney length in different gender

	Gender	N	Mean	Std. Deviation	Std. Error Mean
RTK length	Male	173	8.403	1.0253	.0777
	Female	127	8.240	1.0356	.0915
LTK length	Male	173	8.602	1.0658	.0808
	Female	127	8.385	1.0180	.0900
RTK width	Male	173	3.338	.4344	.0329
	Female	127	3.222	.6162	.0545
LTK width	Male	173	4.127	.6528	.0495
	Female	127	4.031	.5682	.0502

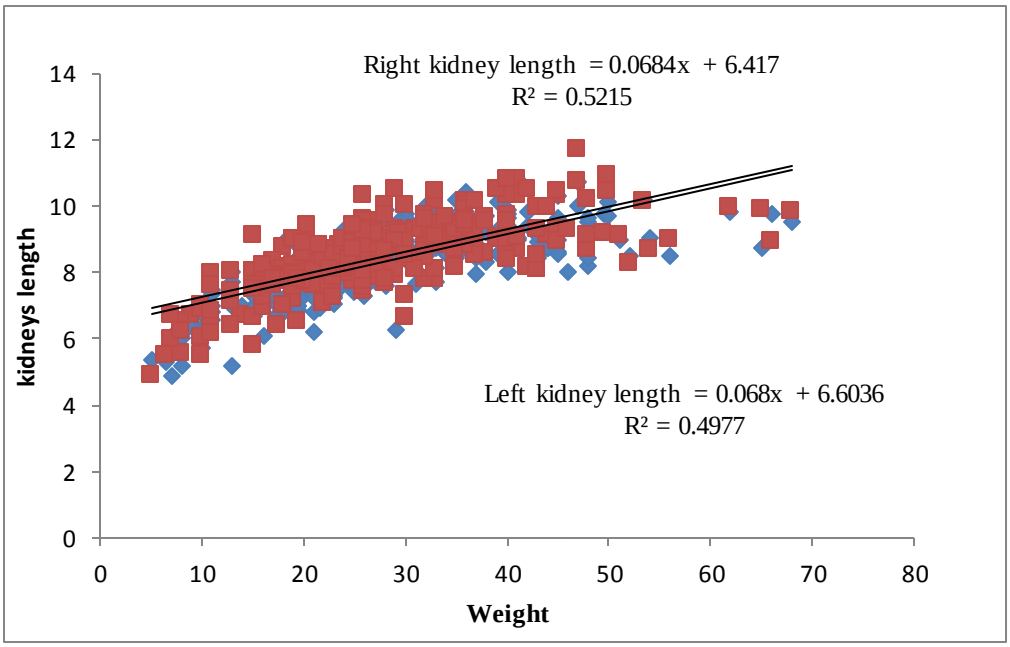

Figure (1) scatterplot shows relationship between weight and both kidney length

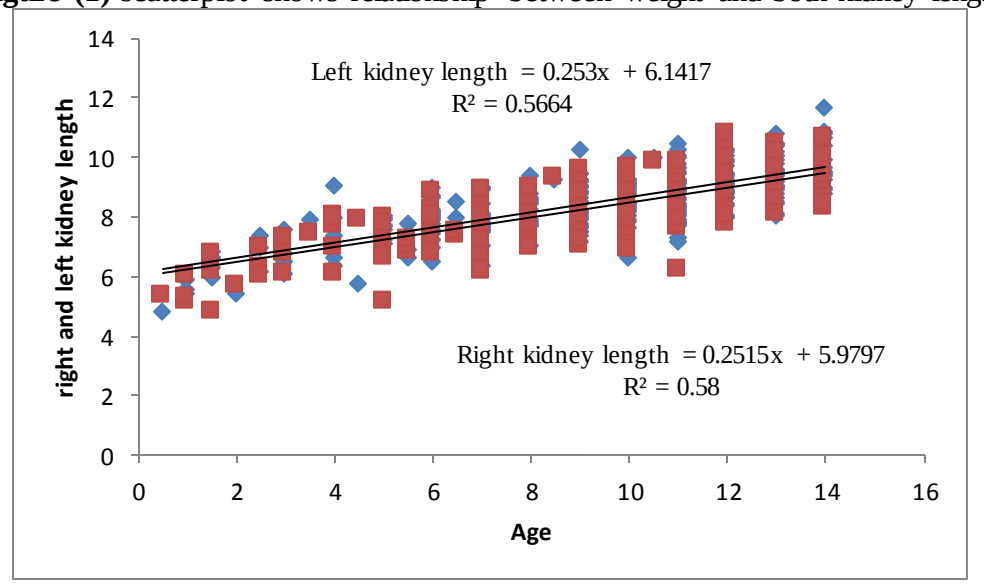

Figure (2) scatterplot shows relationship between age and both kidney length

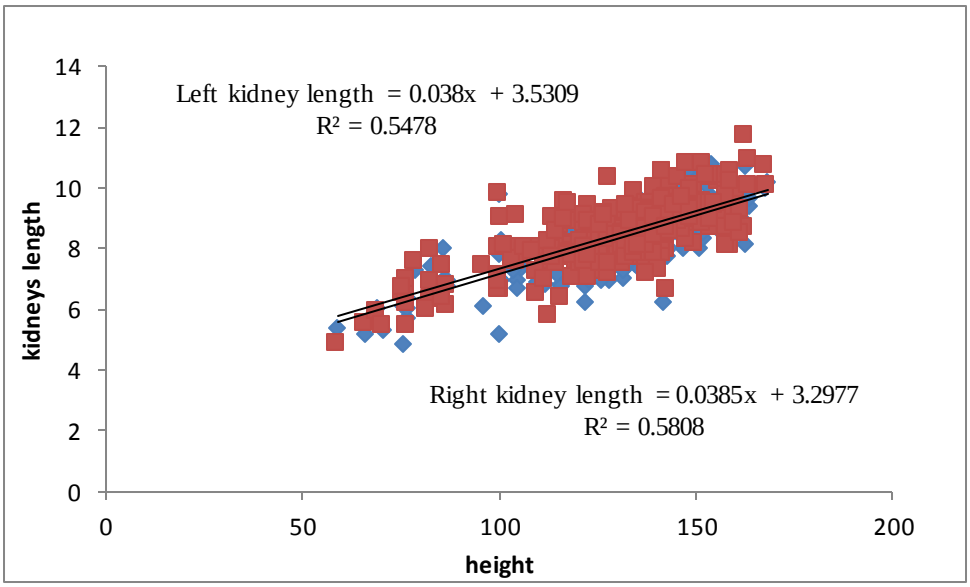

Figure (3) scatterplot shows relationship between height and both kidney length

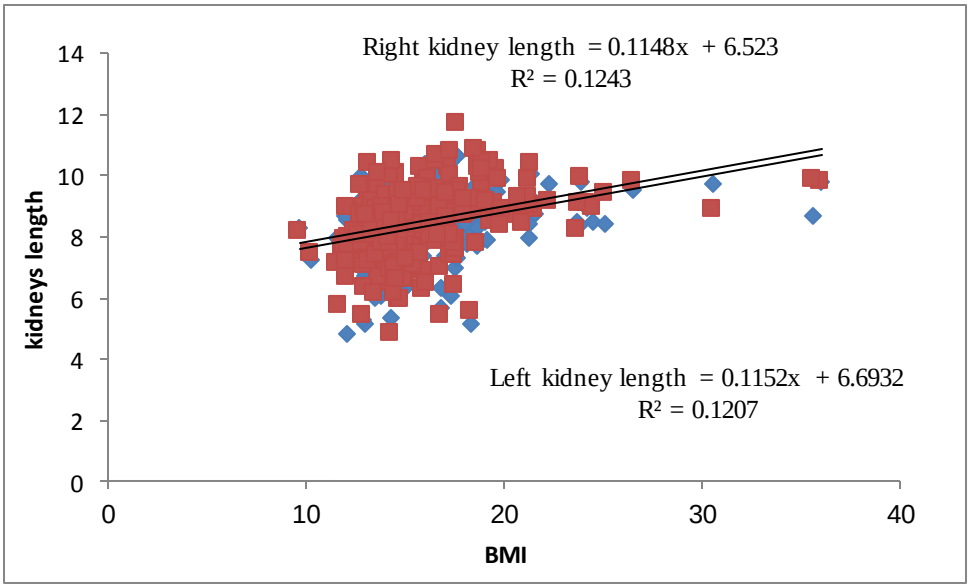

Figure (4) scatterplot shows relationship between BMI and both kidney length

4. Discussion:

The normal values of visceral organ dimensions are important parameters during Sonographic examinations (Mittal and Chowdhary, 2010). In the present study, kidney dimensions were

analyzed in terms of length and width. The study found that Right kidney length measurement was 8.33 ± 1.03 cm, ranged from 4.9-10.8 cm while left kidney length was 8.51 ± 1.05 cm with ranged 4.9 - 11.7 cm, these results were comparable with the previous study (Eze et al., 2014). The present study showed that the left kidney is longer than right kidney. This result was supported by the studies showed that the left kidney is slightly larger than the right kidney. This slightly greater variation in the length of the left kidney may be due to increased noise in the sonograms of the left kidney; also spleen is smaller than the liver, so the left kidney has more space to grow and it does not provide as large an acoustic window as the liver (Eze et al., 2014, Kim et al., 2013).

The present study has shown that there were no significant differences in measured kidneys with respect to gender ($p > 0.05$). This finding is similar to the findings of other previous authors (Eze et al., 2014, Safak et al., 2005, Soyupak et al., 2002). Therefore, gender certainly is not a determining factor for kidney dimensions in children in this population.

The morphology of visceral organs varies from person to person. During the maturation process from infancy through adolescence, growth of visceral organs shows a high correlation with gains in height, weight and body surface area (Konuş et al., 1998, Megremis et al., 2004). Among the body parameters, height was the one best correlated with the kidney dimensions followed by weight and age. This observation probably results from rapid body growth that occurs before the attainment of mature body morphology at adult stage. Thus it is easy to predict renal size reliably on the basis of these variables, especially height, in this population. (Konuş et al., 1998) also reported that kidney dimensions showed the best correlation with body height in a Caucasian children population. (Safak et al., 2005, Soyupak et al., 2002), however, reported that kidney dimensions showed the best correlation with body weight among the children population they studied.

It is important for Sudanese to have their own population specific normograms of the kidneys in the studied age group as American and European population data cannot be used as universal patterns. Our results could be generalized to the wider international community where there is need for each country to establish their own specific normograms of kidney size in school-age children with reference to the body parameter that shows the best correlation with kidney dimensions as height and weight might show variation in different ethnic origins or races.

5. Conclusion:

Sonographic determination of pathologic changes in the size of the kidneys necessitates knowing the normal ranges of their lengths, especially with respect to height in this population.

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