ORIGINALES

Ultrasonographic study of kidney size in children

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SUMMARY

Objective: *The objective of this study is the determination of the normal kidney size in children analysing the variables that have a good correlation with it. With these correlations the normal kidney size can be established and a diagnose of possible diseases set.*

Methods: *The data was obtained through ecographies taken in 474 children between 0 and 18 years old that were under control for several reasons differently from the suspicion of a kidney disease. The information related to age, sex, weight, height and corporal surface was also taken.*

Results: *We studied 265 girls and 209 boys. No difference was obtained between the size of the girls and boys kidneys. The regression analysis of the left kidney shows correlations of 0,911 for the height, 0,896 for the corporal surface, 0,863 for the weight and 0,857 for the age; while the one of the right kidney shows correlations of 0,921 for the height, 0,902 for the corporal surface, 0,872 for the age and 0,871 for the weight. The determination coefficients were 0,83 for the left kidney and 0,85 for the right one. The multivariant analysis shows that for both kidneys the height and the age are variables statistically significant as well as the corporal surface for the left kidney.*

Conclusions: *The size parameters measured in the kidneys show a statistically significance correlation with certain parameters of the growing. The maximum correlation appears for the height of the patient, which allows establishing regression equations with the kidney size and the height and therefore to detect any deviations from these regression curve.*

Key words: ***Echography. Children. Kidney size. Height.***

ESTUDIO ECOGRÁFICO DEL TAMAÑO RENAL EN NIÑOS

RESUMEN

Objetivo: *Determinar el tamaño renal normal en la ecografía de los niños, buscando qué variables tienen una buena correlación con el mismo.*

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Metodos: *Se evaluó el tamaño renal de 474 niños de entre 0 y 18 años a quienes se les realizó un estudio abdominal por otros motivos distintos a sospecha de patología renal. Paralelamente se recogieron datos sobre edad, sexo, peso, talla y superficie corporal en todos los pacientes estudiados.*

Resultados: *Se estudiaron 265 mujeres y 209 varones sin encontrarse ninguna diferencia significativa en el tamaño renal con relación al sexo. En el análisis de regresión se encontró, para el riñón izquierdo, correlaciones de 0,911 para la talla, 0,896 para la superficie corporal, 0,863 para el peso y de 0,857 para la edad; y para el riñón derecho 0,921 para la talla, 0,902 para la superficie corporal, 0,872 para la edad y 0,871 para el peso. Los coeficientes de determinación obtenidos fueron de 0,83 para el riñón izquierdo y de 0,85 para el derecho. En el análisis multivariante se muestran como variables estadísticamente significativas la talla y la edad para ambos riñones, y la superficie corporal para el riñón izquierdo.*

Conclusiones: *Los parámetros de medida de riñón mostraron una correlación estadísticamente significativa con algunos parámetros del desarrollo, siendo esta correlación máxima cuando se compara con la talla del paciente, pudiendo elaborarse ecuaciones de regresión para considerar el tamaño renal como normal respecto a la talla del individuo.*

Palabras clave: ***Ecografía. Tamaño renal. Niños. Talla.***

INTRODUCTION

Kidney size is an important parameter in the assessment of a child with renal disease.[1,2] Ultrasonography is useful, non-invasive and cheap method for reliably performing the measurement of kidney size.

Some renal diseases may change the morphological characteristics of the kidney; they may change its size and the ultrasonographic features of the tissues.[3] There are a number of studies showing morphological or architectural kidney changes seen by means of ultrasound and that point to certain renal diseases, either in pathognomonic way or not. However, to date, little importance has been ascribed to normal measures of kidney size in children, in spite of the fact that many diseases progress with an increase or a reduction in kidney size. The change in kidney size may be an evidence of disease, so that it is important that we have normal reference values in children.

Zenkl M. showed, in an ultrasonographic study, that Weitzel's scales were not appropriate to assess kidney size in children and he highlighted the importance of finding body parameters with which to relate kidney measures.[4] The good correlation between kidney size and body parameters, and its usefulness for suspecting renal pathology, has been previously shown in smaller series than ours.[1]

PATIENTS AND METHODS

Data from 498 patients among children of all ages comprised between 0 and 18 years, with no suspicion of renal disease, and in whom an abdominal ultrasound was requested for other reasons were gathered throughout 24 months. Exclusion criteria were the presence of abnormal ultrasound findings evidencing a renal disease, and pregnancy duration less than 36 weeks in infants younger than 3 months.

Two radiologists performed the ultrasound examination with a Core Vision Ultrasound from Toshiba, with multi-frequency (5-9 MHz) longitudinal and convex probes in B-mode, with automatic selection of the frequency by patient's size. Patients were examined in supine decubitus. Measurement of kidney size was considered at the points of maximal length.

Body parameters gathered from each patient were age, gender, weight, height, and body surface area. These data were taken in parallel with the ultrasound examination.

The statistical analysis was done with SPSS 9.0 and Medical® software. Pearson's correlation coefficients and simple regression analysis have been used. Student's t test has been used for comparing numerical data, after checking for their normal distribution (Kolmogorov-Smirnov test). Multivariate analysis was done starting from the maximal model by clearing those variables with a significance level higher than 0.05.

RESULTS

Four hundred and ninety eight children with ages comprised between 3 days and 18.5 years were analyzed. Twenty-four of them were not considered for analysis because of lack proper gathering of all parametric measurements.

Patients mean age was 5.26 years, with a standard deviation of 4.86 years. Median age was 3 years. Among studied children there were 265 females and 209 males. Mean age for female patients was 4.2 years (range: 3 days-16.5 years), with median age of 2.4 years; mean age for male patients is higher, 6.06 years (range: 8 days-18.5 years), with median age of 5.5 years. Their distribution by height is shown in figure 1. There were no differences of kidney size by gender. Data from the right and left kidneys are shown separately since there were small but statistically significant differences between them. Size difference between both kidneys, taking the paired data for each patient, and subtracting left kidney size to right kidney size was –0.098 cm in favor of the left kidney (95% CI: -0.155 - -0.042 cm; $p < 0.0001$).

Regression analysis showed for the left kidney a correlation of 0.911 with height, 0.896 with body surface area, 0.863 with weight, and 0.857 for age. For the right kidney the results were similar: 0.921 for height, 0.902 for body surface area, 0.872 for age, and 0.871 for weight; all of them had a p value < 0.0001.

Regression analysis taking kidney length as dependent variable (Y) and height as the independent variable (X) showed a determination coefficient of 0.8304 for the left kidney, obtaining the following regression equation: $Y = 2.5372 + 0.0479X$; for the right kidney, the result for the determination coefficient was 0.8478, obtaining the following regression equation: $Y = 2.5815 + 0.0464X$.

Height and age appear to be independent and statistically significant variables in the multivariate analysis for both kidneys, as well as body surface area for the left kidney. The results are shown in Tables I and II.

Figures 2 and 3 show left and right kidney lengths, respectively, by age, including 95% confidence intervals.

Table I. Results of the multivariate regression analysis for the left kidney

	Beta	95% CI	p
Age (years)	-0.098	-0.084 a -0.0112	0.0001
Height (cm)	0.048	0.054 a 0.042	< 0.0001
Body surface area (m^2)	1.148	1.226 a 1.07	0.0034

Tabla II. Results of the multivariate regression analysis for the right kidney

	Beta	95% IC	p
Age (years)	-0.044	-0.057 a -0.031	0.042
Height (cm)	0.052	0.056 a 0.048	< 0.0001

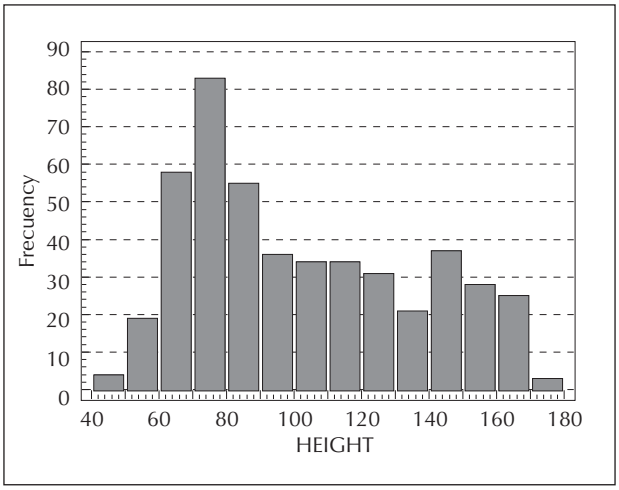

Fig. 1.—

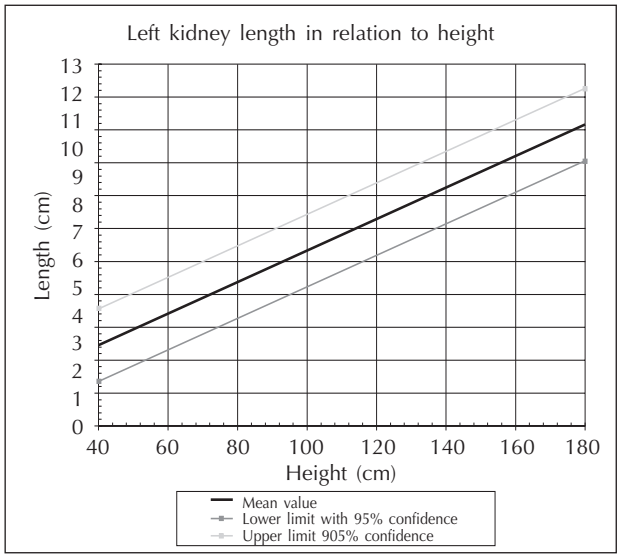

Fig. 2.—

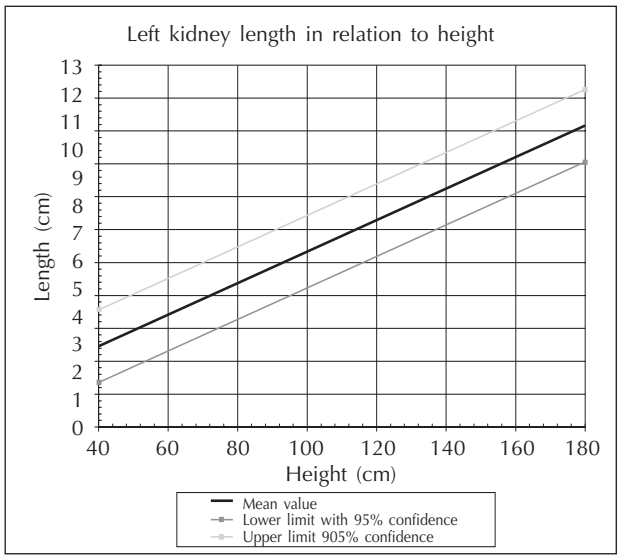

Fig. 3.—¡¡¡¡FALTA TEXTO FIGURA!!!

DISCUSSION

Renal diseases may increase or decrease kidney size, being accompanied or not by changes in normal organ architecture.[1,5-9] Failure in normal kidney growth may also be a sign of renal disease.[10] In this sense, ultrasonography appears to be a new diagnostic modality to perform these measurements, with the advantage of non-invasiveness and safety for the patient as compared to other methods such as plane radiograph of intravenous urography, which also have shown to be effective for assessing kidney size.[5,11]

It is important to know the limits of kidney size of our patients that we may consider normal. To date, no importance has been ascribed to normal kidney size in children, considering a kidney as abnormal when some abnormality of its parenchymatous structure is found or when kidney size is markedly abnormal; maybe because there are no reference parameters for daily use.

Measurement of kidney size by ultrasound or by x-ray significantly varies. The difference may reach up to 20%, an it might be even higher, especially due to the data obtained by x-ray because of image magnification that occurs depending on the distance from the focus with x-rays.[12] Besides, the greater slant that the right kidney has due to its anatomical disposition makes it have less room than the left one, which may explain the differences found in radiographic studies;[13] thus, renal ultrasound is more recommended not only because its greater accuracy for measuring kidney size but also because of its harmlessness.

Our results of the study of 474 children show that renal length correlates with different studied parameters such as age, weight, height, gender, body surface area, which is also shown by other authors.[1,2,4,14,15] Although there are some studies that do not find a significant correlation between kidney size and certain body parameters, this may be due to the small number of studied patients, and more importantly, to the low range of selected parameters, such as weight in newborns.[16]

Similarly to others,[1,5,16,17]we have not found a gender difference with regards to kidney length; neither we have found it when analysing kidney volume, although it does have been referred when measuring kidney volume within the first three months of life; it has been stated that weight mostly accounts for the volume difference between genders, a parameter that has been found to have a correlation in all studies assessing kidney volume,[2] so that it could be a confounding factor.

We have found that left kidney is slightly bigger than the right one, as other authors do,[1,5,7] this difference having been also referred for kidney volume, although some studies have not found such a difference.[17]

Renal measuring parameters showed a good correlation with body parameters, the height being the one having the best correlation. In our study, height accounts for 83% of kidney length variability for the left kidney, and 85% for the right kidney, which is in agreement with that referred by other authors, with both radiology and ultrasound.[1,2] In the multivariate analysis, only age and height still had an statistical significance for both kidneys size.

In the cases in which nephromegaly is not found, we should make the differential diagnosis with metabolic disease, lymphomatous disease with renal involvement, compensating hypertrophy in single kidneys, acute phase and two first weeks after acute pyelonephritis, growing conditions (in which renal morphology is also changed), acute phase of some glomerulonephritis, thrombotic conditions of the renal vein, nephrotic syndrome, and storage diseases involving the kidney.[3,8,9,10,18]

Measurement of kidney size routinely done in ultrasonographic examinations may a useful parameter in the diagnosis and follow-up of renal pathologies, so that we propose normal graphs to assess normality of kidney size in relation to age, which we believe may be more useful than other graphs relating with weight or body volume.[15] In conclusion, we propose some tables with normal values for both kidneys in relation to age, which we believe

may facilitate the follow-up of kidney growth and kidney size in certain conditions.[9,19]

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