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Renal Cortical Thickness in Adults with Normal Renal Function Measured by Ultrasonography

Background/Objective: Renal cortical thickness is an important index for many renal diseases. Ultrasonography has been introduced as an effective method to determine different renal measurements. The objective of this study was to determine the sonographic measurement of renal cortical thickness (RCT) in adults with normal renal function in Isfahan and its relation with gender, age, height, weight, body mass index (BMI), and the side of the body.

Patients and Methods: 142 healthy subjects aged 20-50 years with no history of renal or systemic diseases were studied prospectively. These patients had normal BUN/Cr tests and urine analysis. They also had a normal kidney sonography. Gray scale sonography was used to measure the distance between the outer border of the medulla and the renal capsule, presenting as RCT.

Results: 80 men and 62 women with a mean±SD age of 38.8±7.7 years underwent sonography. The mean±SD RCT was 9.09±0.99 mm. RCT associated with gender (P=0.02) but there was no significant difference between the right and left RCTs (P=0.15). There were significant positive correlations between RCT and renal length and the patients' height, but such a correlation was not observed between RCT and age, BMI, and the patients' weight.

Conclusions: RCT varies with many variables including gender, height and length of the kidney. The results of this study can be used for evaluation of RCT to determine abnormal clinical conditions.

Keywords: Ultrasonography, Kidney Cortex, Adult

Introduction

Ultrasonography is one of the several methods used to evaluate renal morphology. Different studies show that ultrasonography is a rapid and non-invasive diagnostic method for renal diseases and also the first method of choice for screening and follow-up of patients and healthy people.[1] Moreover, ultrasonography has been shown as a proper way for studying acute rejection of the transplanted kidneys, renal collagen-vascular diseases, and diagnosis of renal cystic lesions.[2-4]

As the change in renal cortical thickness (RCT) is an important sign of renal disease, ultrasonographic measurement of RCT has been suggested as an index for studying the health status of the kidney. Measurement of RCT is used for differentiation between acute and chronic renal failure.[5] Although different measures have been reported for normal RCT in various references, measurement of RCT, just like other body sizes, depends on race and body mass. Ablett et al, showed that in normal adult kidneys, sonographic bipolar renal length measurements are reasonably reliable and practical.[6]

There has been no study to determine the measurement of RCT based on the demographic characteristics of our population. Such a study has been completed and reported in our neighboring country, Pakistan, whose reported measures had considerable differences with what we found in our practice.[7] Therefore, the objective of this study was to measure the sonographic values of normal RCT in

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an Iranian population and its analysis based on age, gender, body mass index (BMI), and the side of the body.

Patients and Methods

This cross-sectional study was conducted from January 2007 to July 2007. One hundred and five 20 to 50-year-old volunteered employees from Isfahan university of medical sciences were enrolled in this study. Institutional ethical committee approval was granted, and an informed written consent was signed by each patient.

A personal information form including age and gender of the participant was completed. BMI (weight/height^2 [kg/m^2]) was calculated for each subject, using a Secca scale to measure height (H) and weight (W).

All participants were then examined by a nephrologist and a history of previous or present renal diseases was taken. Those who had any abnormal physical examinations or had any history of kidney diseases (such as frequent urinary tract infections (UTI), or lower urinary tract signs and symptoms), diabetes mellitus, hypertension, atherosclerosis, collagen-vascular diseases, systemic infections, or abnormal urinary or biochemistry laboratory tests in their history were excluded from the study.

At the next step, urinalysis, blood urea nitrogen (BUN), and creatinine (Cr) were performed for all participants in a single laboratory. In the meantime, the participants underwent kidney ultrasonography. If abnormal laboratory tests were reported for any of the subjects, the data were excluded from the study. A serum Cr >1.2 mg/dL and BUN >20 mg/dL were considered abnormal. Those who had presence of proteinuria, urinary casts, or more than five red or white blood cells in the urinalysis report were also excluded from the study.

All ultrasonographies were performed by the same radiologist. Gray scale sonography was preformed for all subjects, using a 3.5-5 MHz multi-frequency curvilinear probe (Siemens G50, Germany). Participants were examined in supine oblique positions, left and right for each kidney and the distance between the renal capsule and the external margin of the hypoechoic medulla was measured in four points—the upper pole, lower pole, and two points of the lateral cortex—for each kidney (Fig. 1).

The mean of these four measurements for each kidney was reported as the RCT. The exclusion criteria in this section were abnormalities such as a small kidney, irregularity in renal surface, hydronephrosis, renal stone, renal duplication, and ectopia.

Data were analyzed by SPSS® for Windows® ver. 11.5. Data of the right and left kidneys were compared with *Student's t* test for paired data. In addition, Pearson's correlation coefficient was used to determine the linear correlations between the RCT and other continious variables. One-way ANOVA was used to compare the means among more than two groups. Data were presented as mean (CI 95%) and mean±SD. A P-value <0.05 was considered statistically significant.

Results

Of the 155 volunteers, 13 were excluded from the study because of the renal abnormalities found in the history, physical examination or sonography. Five participants had a history of UTI, two had a history of proteinuria, two had pyuria, two had a unilateral small kidney, one had renal ectopia and one had renal duplication.

Of 142 studied participants, 80 (56.3%) were male and 62 (43.7%) were female.

The mean±SD age of participants was 38.8±7.7 (range: 20–50) years. The mean±SD height of the studied subjects was 165.1±10.6 (range: 150–189) cm.

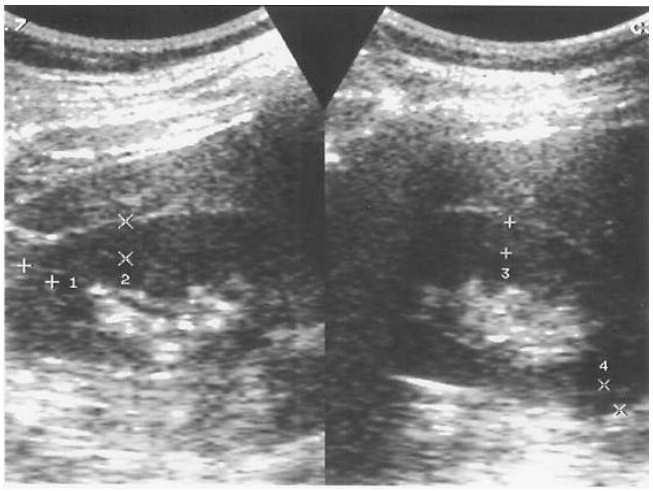

Fig.1. The sonographic view of the measurement of renal cortical thickness in four points of the kidney.

They had a mean±SD weight of 71.3±12.8 (range: 36–120) kg. The mean±SD BMI of participants was 26.2±4.6 (range: 13.4–39.7) kg/m^2.

The mean RCT was 9.1 mm (CI 95%: 8.9–9.3 mm). The mean RCT was 9.0 mm (CI 95%: 8.83–9.21 mm) for the right kidney and 9.2 mm (CI 95%: 9.0-9.4 mm) for the left kidney (P= 0.15).

The mean RCT was 9.3 mm (CI 95%: 9.0–9.5 mm) in men and 8.9 mm (CI 95%: 8.6–9.1) in women (P= 0.02).

In men, the mean RCT of the right and left kidneys was 9.2 (95% CI: 8.9-9.4) and 9.4 (95% CI: 9.1–9.6) mm, respectively (P=0.12). In women, the mean RCT of the right and left kidneys were 8.8 (95% CI: 8.6–9.1) and 8.9 (95% CI: 8.6–9.2) mm, respectively (P=0.7).

In our study, the mean length of kidneys was 102.2 (95% CI: 101.1–103.4) mm. The mean length was 102.5 (95% CI: 101.1–104.0) and 101.9 (95% CI: 100.7–103.2) mm for the left and right kidneys, respectively (P=0.34). In both sides, there were weak positive correlations between the RCT and the kidney lengths (r=0.27, P=0.001 for the right; and r=0.29, P<0.001 for the left kidney).

There was no correlation between the left kidney RCT and its length in women (r=0.10, P=0.2), whereas women's right kidney RCT and the men's left and right RCTs had weak positive correlations with the renal length (r=0.284, P=0.02 for women's right kidney and r=0.12, P=0.42 and r=0.345, P=0.002 for men's right and left kidneys, respectively).

Totally, there was no significant correlation between age and RCT (r=0.13, P=0.128). In addition, there was no significant difference between RCTs of different age groups (P=0.43).

There was also no significant correlation between BMI and RCT (r=0.21, P=0.806). A weak positive correlation was found between RCT and the mean height of participants (r=0.21, P=0.014). However, there was no significant correlation between the RCT and the mean weight of subjects (r=0.14, P=0.095).

Discussion

Most of the previous studies have measured the length of the kidney and its relation with other factors. Few studies have evaluated the RCT and its relation with some other factors such as age, gender, weight, and height. We know that RCT depends on ethnicity and some environmental factors. To establish some preliminary data on our population, we determined the RCT in subjects without known renal diseases and its correlation with some factors.

In the two other studies using arteriography, the normal RCT has been reported as 5–12 mm in one[8] and 5–8 mm in another.[9] The above results are in approximate agreement with our findings (mean±SD RCT of 9.1±1.0 mm). In another study, using Doppler ultrasonography, the normal RCT has been reported as 10–15 mm[10] which is slightly higher than our findings. They calculated the RCT from two measurements in the upper and lower poles of the kidney, hence, different results might be expected. Buchholz et al, at Karachi university, Pakistan, have reported a mean±SD RCT of 16±2 mm,[7] which has significant difference with our results; however, this can be the measurement of the mean parenchymal thickness. If this was the mean RCT, considering that Pakistan is one of our neighbours, more regional studies are warranted. The variation in cortical thickness is a reflection of the wide range of renal size and configuration of the collecting system. In kidneys with short and stocky infundibuli, the cortex appears thicker than in kidneys with elongated, spidery infundibuli.[8]

We found that there is a significant difference between the mean RCT in men and women (P=0.02). It seems that this difference between men and women is due to a difference between their body metabolism.

Buchholz et al, has reported the mean kidney length as 104±8 mm. They also found that there was no significant difference between the right and left kidney lengths.[7] These results are in agreement with our findings.

We showed that RCT has a weak positive correlation with renal length. Furthermore, some references reveal that there is a relationship between the subject's height and renal length.[5] Therefore, our finding in this study—the correlation between the subject's height and RCT—could be expected.

Although some references report that the renal length decreases by aging[5] and that we expect RCT also to decrease by age, we did not observe any significant correlation between age and RCT. Absence of this expected correlation in our study might be due to

the age of our subjects (20–50 years).

There was no significant correlation between BMI and RCT. There was also no significant correlation between the subjects' mean weight and RCT. These results were expected, considering that weight and BMI are both affected by body fat content and that fat has no effect on body metabolism. We think that a significant result would have been found if we studied the correlation between RCT and the lean body mass.

Finally, it seems that more population-based studies with a larger sample size are necessary to establish the normal values of the Iranian population to set the local reference values.

The RCT is mostly useful in differentiating chronic and acute renal insufficiency, because in most chronic renal failures, renal cortical thinning would be present; on the other hand, in acute states of renal failure, we do not expect a decrease in RCT.

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