Relationship between sonographic renal length and renal parenchymal thickness in normal adult Southeast Nigerians

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Summary
Aim: **To determine the relationship between sonographic renal parenchymal thickness (RPT) and renal length (RL) in normal adult Nigerian.**
Study design: **The RL and RPT of 309 normal subjects within the age range of 18 – 80years were measured sonographically and prospectively. Correlation was performed between RL values and RPT using Pearson Linear 'r' test**
Results: **The range of RL value were 8.5-12.9cm and the corresponding mean were 10.33± 0.7cm and 10.45± 0.63cm for the right and left kidneys respectively. The range of values for the RPT was 1.40 – 2.4 and the corresponding mean values were 1.91± 0.20cm and 1.95± 0.19cm for the right and left kidneys respectively. There was a strong positive correlation between RPT and RL (r = 0.72 and 0.77 for the right and left kidney respectively. However for RL values above 11.0cm the RPT values fluctuated.**
Conclusion: **From this study, for RL above 11.0cm there was no relationship with RPT. The study suggests that for our population groups, kidneys with RL lower than 8.5cm and RPT of 1.40cm or less should not be biopsied in contrast to webb's criteria.**

Keywords: ***Sonography, Renal length, Renal Parenchymal Thickness, Renal Biopsy.***

Résumé
But: Pour déterminer le rapport entre l'épaisseur parenchymal rénale sonographic (RPT) et la longueur rénale (RL) dans le nigérien normal d'adulte.
Conception D'Étude: Le RL et le RPT de 309 sujets normaux dans la marge d'âge de 18 – 80 years ont été mesurés sonographically et pour l'avenir. La corrélation a été exécutée entre les valeurs de RL et le RPT en utilisant Pearson essai de ' r linéaire'
Résultats: La gamme de la valeur de RL étaient 8.5-12.9cm et le moyen correspondant étaient 10.33+ 0.7cm et 10.45+ 0.63cm pour les reins droits et gauches respectivement. La gamme des valeurs pour le RPT était 1.40 - 2.4 et les valeurs moyennes correspondantes étaient 1.91+ 0.20cm et 1.95+ 0.19cm pour les reins droits et gauches respectivement. Il y avait une corrélation positive forte entre le RPT et le RL (r =0.72 et 0.77) pour le rein droit et gauche respectivement. Cependant pour des valeurs de RL au-dessus de 11.0cm les valeurs de RPT ont flotté.
Conclusion: De cette étude, pour RL au-dessus de 11.0cm il n'y avait aucun rapport avec le RPT. L'étude suggère cela pour nos groupes de population, les reins avec RL inférieur 8.5cm et RPT de 1.40cm ou moins ne devraient pas être biopsiés contrairement aux critères des webb.

Introduction

Ultrasound is an essential initial investigation in patients presenting with renal failure, and can be used to identify end stage kidneys and give prognostic information[1]. Renal biopsy is often necessary to make an accurate diagnosis[1].

Several authors have studied ultrasonic renal parameters in an attempt to establish their relevance in evaluation of specific renal disease processes[1]. Renal size is non-discriminatory in determining specific disease processes[2]. Hricak et al[3] observed that many patients with renal parenchymal abnormality had normal echogenicity and that increased echogenicity does not correlate with any specific type of renal disease. On renal Doppler studies, 70% of patients with parenchymal disease have a normal resistive index (RI), and the RI shows no correlation with cortical echogenicity or serum creatinine[4]. Renal length is considered to be an insufficient independent indicator of chronic renal disease (CRD), as some normal length kidneys with thin renal parenchymal thickness (RPT) were noted to have poor prognosis after biopsy[5].

Webb[6] recommended use of parenchymal echogenicity, thickness, and duplex Doppler evaluation of renal blood flow as methods of defining the nature of parenchymal disease. Studies carried out by Roger et al[5] and Webb[6] advocated that RL and RPT, as well as clinical findings, should be considered in the decision whether or not to perform a renal biopsy. Roger et al[5] also noted that RL and RPT were linearly related and thus not surprisingly, patients with chronic renal disease had smaller kidneys. Nephrologists and radiologists are cautious when considering patients with small kidneys for biospy[7]. It is generally accepted that renal biopsy should not be performed if the renal length is less than 9cm or the renal parenchymal thickness is 1cm or less[6]. These recommendations defined our interest in establishing population specific RL and RPT, expecting that by providing population specific values, racial bias will be abolished and more precise values obtained that can be confidently used to identify end stage kidney

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disease and select patients for renal biopsy. This study aims to establish a relationship between sonographic RPT and RL in healthy adult Nigerians from the Southeast geographical zone.

Materials and methods

Scope of the study

The study was carried out at University of Nigeria Teaching Hospital, Enugu and Federal Medical Centre, Abakaliki. These hospitals have the Southeast geographical zone of Nigeria as their catchment areas. The study took place between August 2001 and November 2002. Adults within the age range of 18-80 years were included in the study.

Patient selection

The RL and RPT of 309 subjects were measured prospectively with ultrasound. Subjects were included in the study only if they; had no history of renal or malignant disease, were non-pregnant if females and were also aged 18 years and above. Subjects further qualified for recruitment if as part of this management work, normal renal function was confirmed by plasma electrolytes with the following limits.

Na^+ - 135 – 146 mmol/L,

K^+ - 3.5 – 5.2 mmol/L,

HCO_3 23 – 30 mmol/L and urea 3.3. – 6.7mmol

In addition, only patients whose renal outlines were clearly visible on ultrasound scanning and patients in whom it was possible to obtain three RPT measurements from each side of the upper, lower and the mid level poles of the kidney were included.

Scanning technique

All subjects underwent real time ultrasound scans using 3.5 mHz transducers with a Medison's sonoace 3200 or a siemens SL-1 machine. Longitudinal scans were performed with the patient in the lateral decubitus position and occasionally with the patient in supine oblique position[5]. Several scans through the long axis of the kidney were made to ensure that the measurements were accurate. The RPT at the upper, lower and mid level poles of the kidney were measured for each kidney using electron calipers calibrated for an assumed velvety of $1540ms^{-1}$ in soft tissue

The RL of each kidney was determined by measuring the maximum distance from the cephalad to the caudal margin (figure I) while RPT measurements were made from the outer renal cortical margin to the outer margin of the sinus echoes at each site (figure 2). The renal length and renal paranchymal average RPT was obtained by summing up all the RPT measurements and the mean value was then used for further analysis. Two operators obtained these measurements for each patient to minimize inter observer error.

Data analysis

Results are reported as mean± standard deviation (SD). Descriptive statistic was used in calculating the mean RL and RPT, while the correlation between RPT and RL was performed using Pearson's Linear 'r' – test

Results

Tables 1 and 2 show the distribution of subjects with their RL values and corresponding mean RPT for right and left kidneys respectively. Both tables show a steady increase in mean RPT for a corresponding increase in RL, from RL of 8.5cm to 10.0cm. It then plateaus

Table 1 Distribution of subjects with right RL and corresponding mean RPT

Right RL (cm)	Frequency	Percentage	Right mean RPT (cm)
8.5 – 8.9	5	1.62	1.62
9.0 – 9.4	44	14.24	1.81
9.5 – 9.9	62	20.06	1.86
10.0 – 10.4	86	27.83	1.94
10.5 – 10.9	48	15.53	1.94
11.0 – 11.4	42	13.60	2.00
11.5 – 11.9	14	4.53	1.88
12.0 – 12.4	6	1.94	2.06
12.5 – 12.9	2	0.65	1.92
Total	309	100.0	

RPT = 1.162 + 0.068, RPTV RL, r = 0.76

Table 2 Distribution of subjects with left RL and corresponding mean RPT

Left RL(cm)	Frequency	Percentage	Left mean RPT(cm)
8.5 – 8.9	3	0.97	1.64
9.0 – 9.4	31	10.03	1.86
9.5 – 9.9	51	16.50	1.88
10.0 – 10.4	74	23.95	1.96
10.5 – 10.9	68	22.00	1.96
11.0 –11.4	49	15.86	2.01
11.5 –11.9	21	6.80	1.90
12.0 – 12.4	10	3.24	2.18
12.5 – 12.9	2	0.65	1.95
Total	**309**	**100.0**	

RPT = 1.11 + 0.077 (RPTV RL, r = 0.77)

Table 3 Mean RL & RPT of Subjects with Standard deviations (SD).

Kidney	RL(cm)	SD(cm)	Range (cm)	RPT (cm)	SD (cm)	Range (cm)
Right	10.33	0.70	8.5 – 12.5	1.91	0.20	1.40 – 2.37
Left	10.45	0.63	8.6 – 12.8	1.95	0.19	1.47 – 2.40

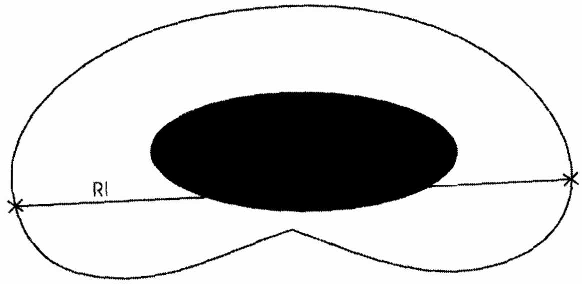

Figure 1. Diagram of Longitudinal Ultrasound scan showing where the measurement of renal length was made.

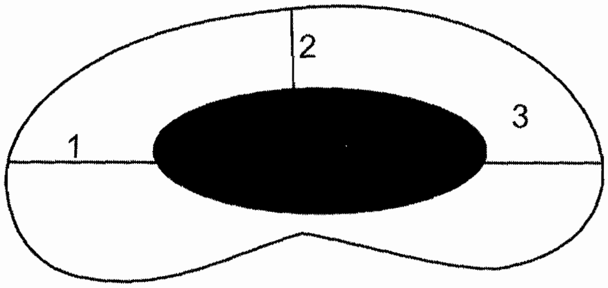

Figure 2. Diagram of Longitudinal Ultrasound scan showing where the three measurements of renal Parenchymal thickness were made

$$\mathbf{RPT} = \left(\frac{1+2+3}{3}\right)$$

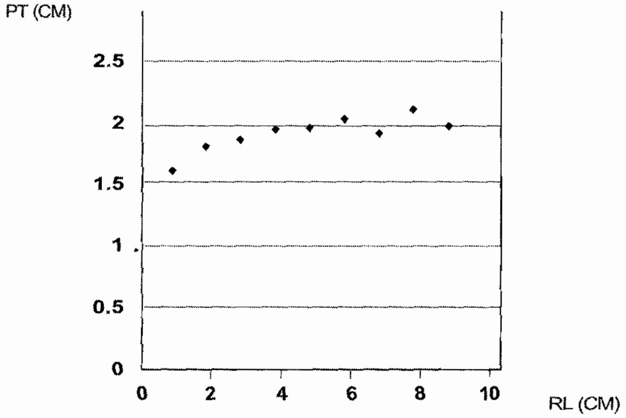

Figure 3. Scatter diagram of mean right RPT Vs mean right RL

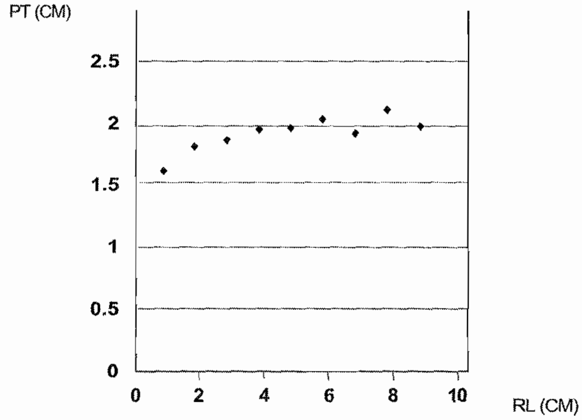

Figure 4. Scatter diagram of mean left RPT Vs mean Left RL

between RL of 10.0 to 10.9cm and fluctuates between RL of 11.0 to 12.9cm.

Linear regression equations obtained for the derivation of RPT from RL for both right and left kidney gave the following values:

RPT (Right kidney) = 1.162 + 0.0068RL (r = 0.76)

RPT (Left kidney) = 1.11 + 0.077RL (r = 0.77)

Table 3 shows the mean RL and RPT of subjects and their standard deviations. Figure 3 and 4 are scatter diagrams showing the mean RPT against the RL for right and left kidneys respectively. There was strong positive correlation between RPT and RL.

Discussions

The present study has shown that the overall mean RL of the right kidney is 10.33 ±0.70cm (range 8.5-12.5cm) and of the left kidney 10.45 ± 0.63cm (range 8.6-12.8cm). The above findings are in agreement with the average kidney length of 10-12cm reported by Meschan[8]. Compared with Caucasian values, these observed values for southeast Nigerians appear smaller. For instance, Brandt's study indicated a mean RL of the right kidney of 10.74 ± 1.35cm and the left kidney of 11.0 ± 1.15cm[9]. Similarly, Roger and colleagues established that the overall mean length of the left kidney was 10.79 ± 1.33cm (range 8.2 –14.4cm) and of the right kidney 10.86 ± 1.41cm (range 8.4-15.2cm)[5]. McMinn also reported higher values for the Caucasian population he studied[10]. Racial differences in renal lengths have been attributed to genetic and environmental variations[11].

In this study, the mean RPT of the right kidney was 1.91 ± 0.20cm (range 1.40-2.37cm) and of the left kidney of 1.95 ± 0.19cm (range 1.47 – 2.40cm). The combined mean RPT was 1.94 ± 0.20cm (range 1.44-2.39cm) compared to 1.89 ± 0.36cm (range 1.1-2.9cm) reported for a Caucasian population[5]. The relationship between the average RPT and RL is shown in figs 3 and 4. There was a strong linear relationship between the two renal parameters (r=0.76 and 0.77 for right and left kidney respectively). Roger et al[5] also established a good linear relationship between the RL and RPT (r=0.64, P<0.001) but their sample size was limited to 64 subjects.

Although, there was a strong positive correlation between RPT and RL, there was considerable fluctuation in RPT values at RL value above 11.0cm in our study (Tables 1 and 2). Therefore, this study agrees with Roger et al [5] that RL would be an insufficient independent indicator of CRD. Brown[1] noted that RL depends on patient habitus and its measurement subject to considerable observer variability. A difference of up to 1.85 cm was reported by Ablett et al[12].

Using the regression equation RPT = 1.162+0.0068 RL for the right kidney and RPT = 1.11 + 0.0077 RL for the left kidney, if the RL alone is obtained in a busy practice, the RPT values can be calculated from these equations. These equations could also be fed into the computer of the ultrasound system and automatically obtained. The normogram thus obtained could be used to ensure that both the RPT and RL are of the pre-requisite values in patients who are to be selected for biopsy. Indications for renal biopsy vary from center to center. Decisions for a biopsy are based on clinical, serological and imaging findings, as well as physicians' preferences[13,14].

From our study, we find out that the equivalent Webb[6] figures given as criteria for selection of patients for biopsy may be: readjusted for patients in Nigeria to be kidneys with RL lower than 8.5cm and RPT of 1.40cm or less should not be biopsied.

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