J. Expt. & Clin. Anat. 5(1): 1-5 (2006).

JECA

Sonographic Evaluation Of Normal Renal Indices In An Adult Nigerian Population

*C. U. EZE AND A. O. OKARO

Department Of Medical Radiography And Radiological Sciences, Faculty Of Health Sciences And Technology, College Of Medicine, University Of Nigeria, Enugu Campus, Enugu State, Nigeria. **E-mail**:ezecharlesu@yahoo.com

*Author for correspondence

ABSTRACT

The objective of this study was to evaluate sonographically the normal renal indices among Southeast Nigerian adults and to verify possible correlations with age, height and body weight. A total of 310 subjects (135 men and 175 women) were randomly selected for the study. The subjects' ages ranged from 18 to 80 years (mean = 38 ± 10.6 years). The heights of the subjects ranged from 1.45 to 1.85m (mean = 1.64 ± 0.08m) whereas their weight ranged from 46 to 102kg (mean = 65.8 ± 6.3kg). The mean body surface area (BSA) was significantly greater in men than in women ($P < 0.05$). There was no statistically significant difference between the mean renal indices (R1) of men and women for the right and left kidney respectively ($P > 0.05$). When both sexes were combined, the mean left R1 was found to be statistically greater than the mean right R1 ($P < 0.05$). Thus the normal values of R1 are 25.65 ± 3.62cm and 26.68 ± 3.64cm for the right and left kidneys respectively. There was poor correlation of R1 with subjects' age, height and body weight, which may be due to non-dependant of R1 on body size. Results suggest that renal index is a good parameter for the assessment of renal size in adults because it is independent of gender and body size.

KEYWORDS: Renal Index, Biometry, Ultrasonography.

Measurement of the kidney size is an integral part of the assessment of the renal tract in adults. Comparison with normal values aids in the diagnosis of both unilateral and bilateral renal diseases (Sergeant and Wilson, 1992). Notably, the presence of close relationship between kidney sizes and functions (Ninan et. al. 1990) has stimulated research related to kidney sizes which are known to be helpful in the diagnosis of kidney diseases.

Renal index was found to be a reliable predictor of renal size in a previous study using intravenous urography (Friendenberg et. al., 1965) because it was found to be independent of body size and race. Intravenous urography is an invasive procedure and it also produces magnification of radiographic images (Dorph et. al., 1977). Sonographic measurements are now regarded as the standard for assessment of renal size and numerous published normal values compare sonographic renal length, volume, area or parenchymal thickness with age, sex, height and body weight.

To our knowledge, there is paucity of published data in our locality on sonographic assessment of renal size by renal index. The present study was, therefore, undertaken to evaluate the normal renal indices among Southeast Nigerian adults and to verify possible correlations with age, height, and body weight.

MATERIALS AND METHODS

Scope

The study was carried out at University of Nigeria Teaching Hospital, Enugu and Federal Medical Center, Abakaliki. These hospitals have the Southeast geographical zone of Nigeria as their catchments area. The study took place between August 2002 and November 2003.

Subjects

The renal length and width of 310 subjects (135 men and 175 women) were measured prospectively by ultrasonography. The age of the study population was between 18 to 80 years. Subjects were randomly selected into the study based on the following inclusion criteria:

(1) No acute or chronic disease that could lead to renal impairment;
(2) No personal or family history disease;
(3) Subject whose renal outlines were clearly visible on ultrasound scan;
(4) Non-pregnant females.

Scanning Techniques

All subjects underwent real time ultrasound scans using 3.5MHz 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 or in supine oblique position. Several scans through the long axis of the kidney were made to ensure that the measurements were accurate.

Length and width of both kidneys were measured. The major distance between the renal poles (superior and inferior) was taken as the kidney length. The major distance between the lateral and medial borders perpendicular to the length was taken as the kidney width.

Body surface area (BSA) of each patient was calculated using the following formula by Dubois and Dubois (1961):

$BSA = Weight^{0.425} \times Height^{0.725} \times 0.007184.$

The renal index (R1) of each patient as defined by Friendenberg et. al. (1965) was calculated according to the following formula:

$$\text{Renal Index} = \frac{\text{Length (cm)} \times \text{Width (cm)}}{\text{Body surface area } (m^2)}$$

Apart from the renal measurements, age, sex, height and body weight were recorded in all subjects. Two experienced operators obtained these measurements for each patient to minimize inter observer error.

Statistical Analysis

Results are reported as mean (x) $\pm$ standard deviation (SD). The mean BSA of men and women were compared by Z-test statistic. Similarly, the mean R1 of right and left kidneys in men and women were compared by Z-test statistic. The mean renal indices for the left and right kidneys in both sexes were also compared with Z-test statistic. The differences were considered statistically significant when $P < 0.05$.

The correlation of renal indices of the right and left kidneys of both sexes with age, height and body weight were performed using Pearson's linear 'r' test.

RESULTS

Table 1 shows the gender distribution of mean BSA. The mean BSA was significantly greater in men than in women ($P < 0.05$).

Table 2 presents the gender distribution of mean right R1. There was no significant difference between the mean right R1 of men and women ($P > 0.05$).

Table 3 reveals the gender distribution of mean left R1. There was no significant difference between the mean left R1 of men and women ($P > 0.05$).

Table 4 shows the mean renal indices in both sexes. The mean left R1 was significantly greater than the mean right R1 ($P < 0.05$).

The regression equations and the coefficients of correlation (r) of R1 (dependant variable) with age, height and body weight (independent variables) are shown below.

TABLE 1: Gender Distribution of mean BSA (n = 310, 135 males and 175 females)

Gender	Mean BSA	SD
Male	1.76	0.16
Female	1.62	0.15
Both	1.64	0.155

$P < 0.05$ according to $Z-$ test

TABLE 2: Gender distribution of mean right renal index (n = 310, 135 males and 175 females).

Parameter	Male	Female
Mean renal index	25.92	25.39
SD	4.00	3.25
Normal range	25.92 ± 4.00	25.39 ± 3.25

P > 0.05 according to Z – test.

TABLE 3: Gender distribution of mean left renal index (n = 310, 135 males and 175 females).

Parameter	Male	Female
Mean renal index	27.04	26.32
SD	3.80	3.48
Normal range	27.04 ± 3.80	26.32 ± 3.48

P > 0.05 according to Z – test.

TABLE 4: Mean Renal Indices for both sexes (n = 310).

Parameter	Male	Female
Mean renal index	26.68	25.65
SD	3.64	3.62
Normal range	26.68±3.64	25.65±3.62

P < 0.05 according to Z – test.

Renal Indices With Age

The age range of the subjects was 18 to 80 years (mean = 38 ± 10.6 years)

Right R1 = 25.32 + 0.0086 age
(r = 0.032) ..... (1)

Left R1 = 25.58 + 0.029 age
(r = 0.112) ..... (2)

Renal Indices With Height

The height range of the subjects was 1.45 to 1.85m (mean = 1.64 ± 0.08m)

Right R1 = 38.28 0.077 height
(r = -0.161) ..... (3)

Left R1 = 40.13 0.082 height
(r = -0.177) ..... (4)

Renal Indices With Weight

The weight range of the subjects was 46 to 102kg (mean = 65.8 ± 6.3kg).

Right R1 = 28.41 0.042 weight
(r = -0.042) ..... (5)

Left R1 = 33.19 0.099 weight
® = -0.288) ..... (6)

DISCUSSION

Renal size has traditionally been measured on the intravenous urogram. Urographic measurements have the advantage of reproducibility but suffer the disadvantage of geometric magnification in part due to urographic technique and also due to the osmotic diuresis caused by the contrast medium (Griffith et. al., 1975; Dorph et. al., 1977). Intravenous urography is also an invasive procedure. Ultrasonographic renal measurement does not have the problems of magnification and gives measurements approximately 20% less than those obtained at urography (Roger et. al., 1994). Ultrasound imaging is also a non-invasive and easy technique. The method is, however, less reproducible and depends on obtaining scans through the true long axis of the kidney. Oblique longitudinal scans underestimate kidney length.

Several attempts at standardization of normal renal sizes are available in the literature. Simon (1964) determined the ratio of renal lengths to the heights of the second lumber (L2) vertebrae

and their discs and suggested that any kidney vertebral ratio which falls outside the appropriate range was abnormal. This method is, however, not applicable where there are abnormalities of the spine. Attempts to correlate the ultrasonographic renal length to vertebral height (Lewis and Ritchie, 1980) were not practical and have not been adopted. Ojemuyiwa and Esho (1978) measured renal lengths alone and plotted a graph of the renal lengths against the patients' heights. Ludin (1967) suggested that since the kidney may be long and slender, or short and broad, it seemed appropriate to measure both the renal length and width. Body size and volume must be taken into consideration in determining normal renal sizes, since a large body should habour larger kidneys and the shape of the kidney, like for example the shape of the heart corresponds to general body build (Moell, 1956). Friendenberg et. al., (1965) found that renal index is independent of the body size. Renal indices were, therefore, evaluated in this study by ultrasound in order to obtain a more sensitive, accurate, and non-invasive estimation of renal size.

Present study showed that the mean BSA was significantly greater in men than in women ($P < 0.05$). Eze and Okaro (2005a) in their previous work with the same study population found that the mean renal length was 10.3 ± 0.7cm (range 8.5 to 12.5cm) and 10.5 ± 0.6cm (range 8.6 to 12.8cm) for the right and left kidneys respectively. And the mean renal width was 4.4 ± 0.5cm (range 3.2 to 5.6cm) and 4.5 ± 0.5cm (range 3.4 to 5.7cm) for the right and left kidneys respectively.

This study revealed that there was no statistically significant difference between the mean R1 of men and women for right and left kidneys respectively ($P > 0.05$) as shown in Tables 2 and 3. Previous study (Ozoh et. al., 1992) agrees with this finding. Working with the same study population, Eze and Okaro (2005b) found that relative renal length is also independent of gender. This suggests that gender is not an independent determinant factor for renal index. Thus special tables for R1 based gender are not required.

There was a statistically significant difference between the mean renal indices of the left and right kidneys in both sexes ($P < 0.05$). Mogensen and Andersen (1973) and Agu (1996) showed similar findings. Hence the need for normogram of R1 for the right and left kidneys as shown in Table 4. The normal values of R1 include 25.65 ± 3.62cm and 26.68 ± 3.64cm for the right and left kidneys respectively. This normogram will serve as a guide in the assessment of R1 in our population.

The analysis of the regression equations and the coefficients of correlation showed that R1 has a weak positive correlation with age (equations 1 and 2). This suggests that a mild increase of renal indices with advancing age appears to occur. There was a negative correlation of R1 with subjects' height (equations 3 and 4) and weight (equations 5 and 6). These suggests that after the attainment of adulthood, height increase ceases but renal indices may still increase whereas after the attainment of a certain weight, further increase in weight may lead to decrease in renal indices. The non-significant correlation of renal index with age, height and weight in this study may be due to its non dependent on body size. Previous study (Agu, 1996) corroborates these findings. Friedenberg et. al., (1965) also found that renal indices are independent of race since American whites and American Negroes had similar renal indices. However, Ozoh et. al. (1992) found smaller renal indices in a Nigerian (adult) population when compared to Americans living in temperate region and attributed this to non-racial factors such as climate. One study in Pakistan (Bucholz et. al. 2000) also highlights the necessity of investigating renal dimensions for each population, strengthening that European and American populations' data cannot be used as universal patterns.

In conclusion, renal index is a good parameter for the sonographic assessment of renal size in adults because it is independent of body size and gender.

ACKNOWLEDGEMENT

We thank Stanley Ibe for his assistance in statistical analysis.

REFERENCES

Agu FU (1996). Sonographic Assessment of normal renal sizes in adult Nigerians. M.Sc Dissertation submitted to the University of Nigeria, Nsukka. P. 42.

Bucholz NP, Abbas F, Biyabani SR, Afzal M, Javed Q, Rizvi L et. al., (2000). Ultrasonographic renal size in individuals without known renal disease. Journal of Pakistan Medical Association. 50: 12-16.

Dorph S, Sovak M, Talner LB, Rosen L (1977). Why do kidney sizes change during i.v. urography? Investigative Radiology 12: 246-250.

Dubois D, Dubois EF (1961). Clinical calorimetry, 10th paper. A formular to estimate the approximate surface area if height and weight be known. Archives of internal medicine. 17:863-887.

Eze CU, Okaro AO (2005a). Normal renal dimensions in an adult Nigerian population. Journal of experimental and clinical anatomy 4(1): 1-5

Eze CU, Okaro AO (2005b). Sonographic measurement of absolute and relative renal lengths in Southeast Nigerian adults. Journal of experimental and clinical anatomy. 4(2): 16-19.

Friendenberg MJ, Walz BJ, McAlister WH, Locksmith JP, Gallagher TL(1965). Roentgen size of normal kidneys. Radiology 84: 1022-1039.

Griffith GJ, Cartwright G, McLachlan MSF (1975). Estimation of renal sizes from radiographs: Is the effort worthwhile? Clinical radiology. 26: 249-256.

Lewis E, Ritchie WGM (1980). A simple ultrasonic method for assessing renal size. Journal of clinical ultrasound. 81: 417- 420.

Ludin H (1956). Size of normal kidneys. Acta Radiologica (Diagnosis) (Stockolm) 46: 640-645.

Mogensen CE, Anderson MJF (1973). Increased kidney size and Glomerular filtration rate in early juvenile diabetes. Diabetes 22(9): 706-712.

Ninan VT, Koshi KT, Niyamthullah MM, Jacob CK, Copalakrishnan G, Pandey AF et. al., (1990). A comparative study of methods of estimating renal size in normal adults. Nephrology Dialysis J. 5: 851-854.

Ojemuyiwa MI, Esho JO (1978). Relationship between renal lengths and heights of Nigerians. Nigerian Medical journal. 8:25-27.

Ozoh JO, Okoye IJ, Umerah BC, Onuigbo MAC, Nwagbo DFE (1992). Normal renal sizes in Nigerians. West African journal of radiology 2(1): 5-10.

Roger SD, Beale AM, Cattell WR, Webb JAW (1994). What is the value of measuring renal parenchymal thickness before renal biopsy? Clinical radiology. 49: 45-49.

Sargent MA, Wilson BPM (1992). Observer variability in the sonographic measurement of renal length in childhood. Clinical radiology 46: 344-347.

Simon AL (1964). Normal renal size: An absolute criterion. American Journal of roentgenology. 92: 270-272.