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Renal Resistive Index in Normal Adults in Ibadan, Southwestern Nigeria: A Preliminary Report

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Abstract

Background

Colour Doppler sonography is used for visualization of blood flow, non- invasive evaluation of vascular resistance and measurements of velocities in renal and intrarenal arteries Its usefulness in the evaluation of the kidneys ranges from the diagnosis of renal artery stenosis and renovascular disease to the assessment of intra renal hemodynamics in several different pathological conditions such as essential hypertension, acute and chronic renal failure, pre and post-transplant assessment and graft rejection.

Objective

To determine the normal value of Renal Resistive Index in a healthy group of individuals in order to compare findings with those in existing literature and to serve as a normogram among Nigerians.

Materialsand Methods

Colour duplex Doppler sonography of interlobar arteries was performed in 68 patients with normal blood pressure, normal blood sugar and no known renal disease or any significant medical condition with normal B-mode sonography of their kidneys. The mean renal resistive index of the interlobar arteries was compared on the right and left, males and females and correlated with age, height, body mass index and renal volume.

Results

The mean renal resistive index was 0.56 (± 0.04) in the right and left kidney. No difference in mean was seen between the males and females. No significant correlation was seen with age, height, body mass index and renal volume.

Conclusion

This study has provided normative value of renal resistive index in a Nigerian population and established this data for use in future studies.

Keywords: Colour doppler, renal arteries

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Background

L'échographie de Doppler de couleur est employée pour la visualisation du flux sanguin, l'évaluation envahissante non- de la résistance et des mesures vasculaires des vitesses dans les artères rénales et d'intrarenal son utilité dans l'évaluation des reins s'étend du diagnostic de la sténose d'artère rénale et du disea renovascular.

Objective

Pour déterminer la valeur normale de l'index résistif rénal dans un groupe en bonne santé de personnes afin de comparer des résultats à ceux en littérature existante et servir de normogram parmi des Nigerians.

Materials and Methods

L'échographie duplex de Doppler de couleur des artères interlobaires a été exécutée dans 68 patients avec la tension artérielle normale, sucre de sang normal et aucune maladie rénale connue ou n'importe quelle condition médicale significative avec l'échographie normale de B-mode de leurs reins. L'index résistif rénal moyen des artères interlobaires a été comparé du côté droit et gauche, des mâles et des femelles et corrélé avec l'âge, la taille, l'indice de masse corporelle et le volume rénal.

Results

L'index résistif rénal moyen était 0,56 (± 0,04) dans le rein droit et gauche. Aucune différence dans le moyen n'est vue entre les mâles et les femelles. Aucune corrélation significative n'a été vue avec l'âge, la taille, l'indice de masse corporelle et le volume rénal.

Conclusion

Cette étude a fourni une valeur normative d'index résistif rénal dans une population nigérienne et a établi ces données pour l'usage dans de futures études.

Introduction

The use of Grey scale renal sonography in the evaluation of both native and transplant renal dysfunction has been well established. However it lacks specificity and sensitivity for detecting medical renal disease especially in the early non-chronic phase of the disease.[1]Colour Doppler sonography is used for visualization of blood flow, non- invasive evaluation of vascular resistance and measurements of velocities in renal and intrarenal arteries.[2]The knowledge of

renal blood flow indices ranges from the diagnosis of renal artery stenosis and renovascular disease to the assessment of intra renal hemodynamics in several different pathological conditions such as pre and post-transplantassessment and graft rejection,essential hypertension, acute and chronic renal failure.[3]

Resistive index is one of the indices used in evaluating the renal vascular resistance. From the initial studies of Rigsby*et al*[4] in the united states on transplanted kidneys and the subsequent work of Rifkin *et al*[5] and Platt *et al*[6], as well as of others[7-13]on the behavior of resistive index in different renal diseases, mean reference value for normal resistive index in adults was determined to be 0.60 plus or minus 0.10, with 0.70 as the upper limit of normal. Investigators in several studies[14, 15-19] have indicated threshold values for renal impairment and values prognostic of poor renal outcome ranging from 0.60 to 0.79.

Exception to this threshold value is seen in children and elderly patients. Mean renal resistive index greater than 0.70 can be seen in the first four years of life and in the elderly patients without renal insufficiency[1].

Many of the reports on renal resistive index have been in the western countries. To our knowledge, there is little published information on renal resistive index in the African population. The aim of this study was to establish normative data for the resistive index of the interlobar arteries of healthy Nigerian adults with the use of color duplex Doppler sonography. This can be compared with the values found in established studies in the Western population.

Materials and Methods

Sixty-eight healthy adults who had normal blood pressure, normal blood glucose and lipid profiles were recruited for this study. Other inclusion criteria for the study were the absence of clinical history of significant chronic medical illness and normal B-mode sonography findings in both kidneys. The women recruited were not pregnant. Informed consent was obtained from all the patients and ethical approval was obtained from the Joint University of Ibadan/University College Hospital Institutional Review Board.

Ultrasound examination of the kidneys including pulsed Doppler analysis of the intra-renal arteries was performed using a General Electric Logiq P5 ultrasound machine with a 2.5-5.0 MHz curvilinear transducer. Patients were scanned after an overnight or about eight (8) hours fast to minimize bowel gas shadows which can obscure the kidneys. Patients were made comfortable on the examination couch and procedure was explained including the need for occasional breath holding when indicated. The grey scale imaging of the kidneys was done with patient in supine, decubitus or prone positions as appropriate. Coupling gel was applied to the lumbar regions and the kidneys scanned in longitudinal and transverse planes using the liver and the spleen as acoustic windows. Measurement of the longitudinal (LS), transverse (TS) and antero posterior (AP) diameter of the kidneys was taken and the volume calculated using the formula: LS X TS X AP X 0.52[20]. The LS span is bipolar length, TS and AP diameters were taken in transverse scan at the level of the renal hilum.

Evaluation of the intra-renal arteries was done through a flank approach with the patient in the decubitus position. The transducer was placed along a lateral or slightly posterior approach and a plane obtained in which no spleen or liver is visible. This ensured that the distance to the intra-renal vessels is minimized. Color Doppler interrogation is essential to map the vascular anatomy (**Fig. 1**). The intra-renal Doppler waveform was obtained at angles less than 30 degrees so that the early systolic peak could be visualized. The transducer was rotated more posteriorly to improve the Doppler angle for the upper pole intra-renal arteries. For the mid kidney, the probe was centered in a coronal plane. The best Doppler angle for the lower pole intra-renal arteries was obtained by rotating the probe slightly anterior to the mid coronal line.Waveforms were optimized for measurement using the lowest pulse repetition frequency without aliasing (to maximize waveform size), the highest gain without obscuring background noise, and the lowest wall filter. Three to five reproducible waveforms from each kidney were obtained (**Fig. 2**) and RIs from these waveforms were averaged to arrive at mean RI values for each kidney. This is obtained by adding the RI from upper, mid and lower pole intrarenal arteries and dividing by 3.

Statistical analysis was carried out with the SPSS 16.0 program for Windows (SPSS Inc. Chicago, IL). Appropriate test of significance such as student's t-test was used. All values in the text and tables are expressed as means ± SD. The correlations were evaluated with Pearson's correlation test. p value of <0.05 was considered statistically significant.

Results

Sixty -eight individuals that fulfilled the inclusion criteria were analyzed. These included 34 males and 34 females. The age range of the study subjects was 30-64 years with a mean age (± SD) of 48.41 (± 8.52) years (Table 1). The mean height was 1.58 (± 0.08) meters with a range of 1.36 1.81 meters while the mean Body Mass Index (BMI) was 25.72 (±3.99) with a range of 19.7 33.90.

Mean renal volume on the right was 110.89 (± 19.06) cm^3 (range 73.90 154.40) while the mean renal volume on the left was 133.78 (± 25.51) cm^3 (range

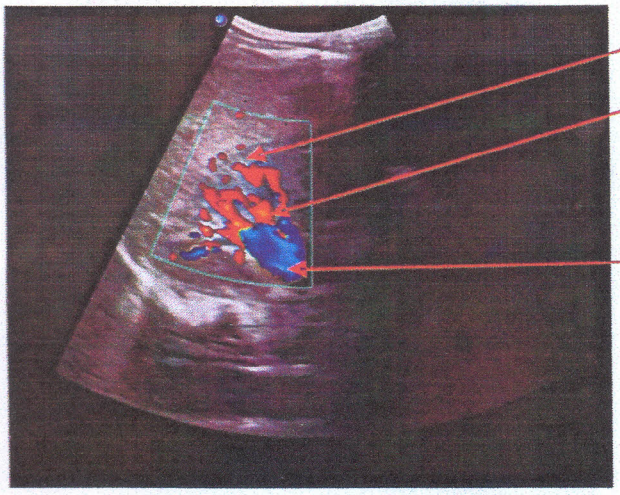

Figure 1: Doppler US showing color flow in the intra-renal branches of the renal artery.

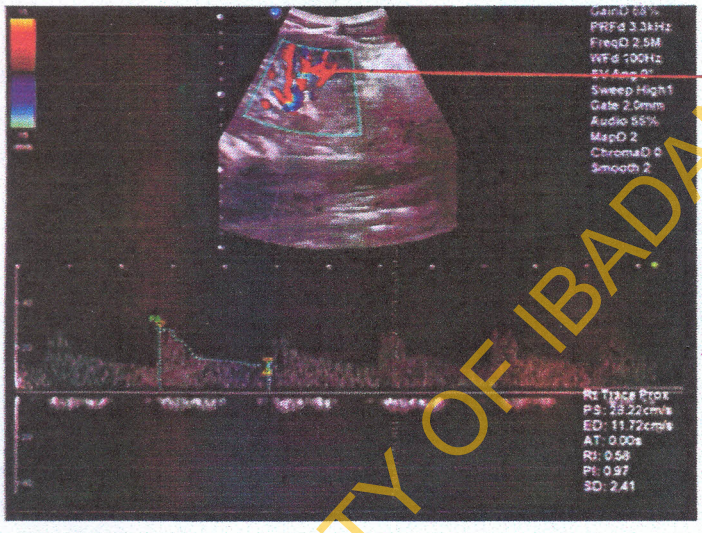

Figure 2: Doppler ultrasound of the kidney showing normal resistive index from the interlobar artery of a healthy kidney taken at the mid kidney

76.3 137.30).

The mean renal resistive index (RRI) was 0.56 (± 0.04) (range 0.48 0.67) and 0.56 (± 0.04) (range 0.48 0.65) on the right and left respectively. No statistical difference is seen in the renal resistive index of males compared with females in the right and left kidney (Table 2). In addition no statistical association is seen between the renal resistive index and age, height, body mass index and renal volume (Table 3).

Table 1: Age group distribution

Age of Respondents	Gender		Total Freq (%)
	Male Freq (%)	Female Freq (%)	
d 40	8(53.3)	7 (46.7)	15 (100)
41-50	11(50)	11 (50)	22 (100)
51-60	13 (44.8)	16 (55.2)	29 (100)
> 60	2(100)	0 (0)	2 (100)
Total	34 (50)	34 (50)	68(100)

Mean ± SD =48.87 ± 8.47

Table 2: Comparison of renal resistive index in males and females in the right and left kidney

Variables	Males	Females	t - test	p- value
Right kidney Mean RRI	0.59 (±0.47)	0.61(±0.30)	0.040	0.969
Left kidney Mean RRI	0.59 (±0.44)	0.60 (±0.39)	0.111	0.912

RRI = Renal resistive index

Table 3: Association between renal resistive index and age, height, body mass index, renal volume

Variables	r	p- value
Age	-0.001	0.993
Height	-0.200	0.103
BMI	-0.045	0.714
Right renal volume	-0.181	0.140
Left renal volume	-0.233	0.056

Discussion

The resistive index provides information about arterial impedance. In order to recognize abnormal renal resistive index in pathologic conditions in the African population, the range of normal values must be established. The mean renal resistive index (RRI) value obtained in this study is 0.56 (± 0.04) on the right and left. This is similar to that obtained by Ozelsancak*et al*[21] in Turkey. They evaluated 40 healthy individuals as control group in a research they conducted to determine the relationship between RRI and inflammation in untreated hypertensive patients and obtained a mean value of 0.56 (± 0.04)[21]. Gottlieb RH *et al*[22] in the United States evaluated the resistive indices of 15 native kidneys from 8 patients with no known renal dysfunction and found a mean value of 0.58. This suggests that there is significant difference in the normal mean renal RRI in the Nigerian population compared with the Western population. The threshold value utilized in other places i.e = 0.70 can therefore apply to the Nigerian population.

In this study, there was no difference in the RRI in the right and left kidneys. This is similar to the finding reported by Mastorakou*et al*[23] in the United Kingdom. Murat *et al*[24] found no significant difference between mean RRI values of the right and left kidney within the age group of the healthy children they studied in Turkey.

Mastorakou*et al*[23] also found no difference in the mean value of RRI in the males and females, similar to the finding in this study.

No significant correlation was seen between RRI and age in this study, suggesting that there is little variation in the RRI of healthy adults within this studied age group (30 to 64 years). Mastorakou*et al* found higher RRI in the oldest age group (7th decade) of their study population, which agrees with the established fact that RRI may be even higher than the threshold (0.70) in the elderly population with no renal dysfunction[1].

No correlation between RRI and height, BMI, and renal volume was found in this study. This suggests that there is little or no influence of body habitus and renal size on the renal vascular impedance.

In conclusion, this study has provided normative value of renal resistive index in a Nigerian population and established this data for use in future studies.

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