Renal Changes in Length and Parenchymal Thickness in Diabetic and Hypertensive Patients with Normal eGFR and Serum Creatinine Using Ultrasonography

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Abstract

This study was proposed to measure the renal length and parenchymal thickness in Adult diabetic and hypertensive patients with normal eGFR and serum creatinine using ultrasonography in order to detect early reduction in renal length and parenchymal thickness in Sudanese population. Ultrasonographic kidney measurements were performed on 66 adult patients with known diabetes and hypertension with different duration of the disease. The impact of age, gender, site (left and right side) and height was statistically analyzed. Patients with abnormal eGFR, serum creatinine or any renal disease were excluded. This study was included 27 males and 39 females with age ranging from 26-75 years. The study was divided into three groups; Group "A" includes 35 patients with diabetes and hypertension (DM & HTN), group "B" includes 15 patients with diabetes only (DM) and group "C" includes 16 patients with hypertension only (HTN). The duration of the (DM and HTN) ranging from 5-30 years.

The mean of right renal lengths were 10.36 ± 0.988, 10.38 ± 1.49421 and 10.20 ± 0.71 cm for DM & HTN, DM and HTN respectively. The mean of left renal lengths were 10.84 ± 0.111 cm, 10.71 ± 1.15 cm and 10.33 ± 0.91 cm for DM & HTN, DM and HTN respectively. No significant difference noted in the right or left renal length. The mean of right renal parenchymal thicknesses were (1.52 ± 0.41 cm, 1.76 ± 0.26 cm and 1.45 ± 0.27 cm for DM & HTN, DM and HTN respectively. The mean of left renal parenchymal thicknesses were 1.90 ± 0.74 cm, 1.9 ± 0.28 cm and 1.75 ± 0.35 cm for DM & HTN, DM and HTN respectively. There is significant difference in right parenchymal thickness at p=0.03.

The numbers of patients with small, normal and large right renal length were 5, 57 and 4 respectively. The numbers of patients with small, normal and large left renal length were 1, 57 and 8 cases respectively. No significant difference among the three groups DM & HTN, DM and HTN.

The numbers of patients with thin, normal and thick right renal parenchymal thicknesses 5, 57 and 4 respectively. The numbers of patients with small, normal and large left renal length were 1, 57 and 8 cases respectively. No significant difference among the three groups DM & HTN, DM and HTN.

These results were correlated with age, gender, site, and height which showed that there is no significant difference between right and left renal length. The significant difference of age was found only in left parenchymal thicknesses at p=0.0. No significant difference of gender or height was noted in renal lengths or parenchymal thicknesses.

The study concluded that the right parenchymal thickness was affected with disease DM&HTN, DM and HTN and the left parenchymal thickness was affected with age.

Keywords: Ultrasonography; Renal length; Parenchymal thickness; Hypertensive; Diabetic; Creatinine

Introduction

Diabetes mellitus (DM), commonly known as diabetes, is a group of metabolic disorders characterized by a high blood sugar level over a prolonged period of time. Symptoms often include frequent urination, increased thirst, and increased hunger. Diabetes is due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the insulin produced.

High blood sugar, can damage the blood vessels in your kidneys [1]. When the blood vessels are damaged, they do not work as well. Many people with diabetes also develop high blood pressure, which can also damage your kidneys. High blood pressure (a condition in which blood flows through the blood vessels with a force greater than normal also called hypertension [2].

Diabetes and hypertension are considered the main causes of chronic renal failure in Sudan [3]. As we know decreasing in renal length and thin cortex are ultrasonographic features of chronic renal failure, in addition to increased cortical echogenicity (echogenic kidneys), small kidney size and loss of Cortico-medullary differentiation in the late stages.

Renal length and parenchymal thickness are valuable diagnostic parameters in urological and nephrology practice. In the adult, each kidney measures approximately 11 cm long, 2.5 cm thick, and 5 cm wide [4]. The normal parenchymal thickness range from 14-18 mm. Further review of the literature shows that renal length varies with age, gender, body mass index and pregnancy [5]. Renal infections/ inflammations, nephrologic disorders, diabetes mellitus and hypertension are the most important co-morbid conditions affecting renal length [6,7]. So the detection of early changes in renal length and parenchymal thickness will help us avoiding renal failure that caused by Diabetes and Hypertension. The current study determined the ultrasonographic renal length and parenchymal thickness in patient with diabetes and Hypertension with normal eGFR and assessed the impact of age, gender, side and height.

Materials and Methods

This prospective observational study was conducted in the department of diagnostic radiology, Dousogi Specialized Hospital in Omdurman city and other government hospitals-Sudan. The study included sixty six patients with known diabetes and hypertension. Patients with abnormal renal function test: eGFR (Estimated Glomerular Filtration rate), high serum creatinine levels, and increased blood urea nitrogen, other renal disease such as cystic or solid masses which can affect the renal dimensions, pregnant females, participant who were unable to change posture for accurate assessment of kidneys during US examination and all patients with anatomical variant of kidneys were excluded, otherwise all adult participants (male or female) with normal Serum creatinine level and normal eGFR were included. Renal length and parenchymal thickness were assessed by ultrasound. The study was carried out between August 2014 and July 2015. Participant's age ranged from 26-75 years. Participants required stopping having food for 6 hours before exam in order to reduce bowel gas. Ultrasound procedure performed according to the protocol of renal U/S scanning as mentioned by Sandra. The examination began with subject supine. If the long axis of the kidney cannot be obtained with the patient supine, Coronal or Sagittal view with the patient in decubitus position should be obtained. An US gel was used and it was put at the top of the transducer to avoid reflection of ultrasound and to maintain a good transmission of US beam inside the body. All the US examinations and measurements were performed using two-dimensional Real Time US machine with curvilinear transducer of 3.5-6 MHz. Once the kidney was located, the transducer was rotated slightly to determine the longest renal axis and renal length was measured as the maximum bipolar dimension in longitudinal plane. Then the renal parenchymal thickness was measured as the distance between outer renal margin and renal sinus. Correlation of renal length and parenchymal thickness with age and gender of the subjects were determined.

Data was analyzed on SPSS-16. Descriptive statistics were applied on the available data. Mean ± SD was presented for age, height, right renal length (RR L), left renal length (LR L), right parenchymal

thickness and left parenchymal thickness. Frequencies and percentages were computed for gender and age groups.

Results

The study included 66 patients, 39 were male and 27 were female. The mean age was 53.9 ± 8.622 ranges from 25 to 75 years old. The patients were divided into three groups 53, 23 and 24% were DM & HTN, DM and HTN respectively. Tables 1 and 2 summarize renal length and parenchymal thickness according to patient's disease with significant difference at p=0.03 noted at right parenchymal thickness. Table 3 summarize renal length and parenchymal thickness according to patient's age with significant difference at p=0.00 noted at left parenchymal thickness. Table 4 summarizes that no significant difference in renal length (right or left) or parenchymal thickness between male and female. Table 5 summarizes that no significant difference among height groups between (right or left) renal length and parenchymal thickness.

Discussion

The mean of right renal lengths were 10.36, 10.38 and 10.20 cm for DM & HTN, DM and HTN respectively. The mean of left renal lengths were 10.84, 10.71 and 10.33 cm for DM & HTN, DM and HTN respectively. All these renal lengths fall in the range of normal limit. Although there was no significant difference among the three groups, either in the right or left renal length but the study showed that the longest renal length was noted in DM group and the shortest one in HTN group. Also the left kidney was slightly larger than the right one, same result noted by Zeb et al. [8].

The mean of right renal parenchymal thicknesses were 1.52 ± 0.41 cm, 1.76 ± 0.26 cm and 1.45 ± 0.27 cm for DM & HTN, DM and HTN respectively. The thickest parenchyma noted in DM group while the thinnest one found in HTN group with significant difference at p=0.03 as showed in Table 2.

The mean of left renal parenchymal thicknesses were 1.90 ± 0.74 cm, 1.91 ± 0.28 cm and 1.75 ± 0.35 cm for DM & HTN, DM and HTN respectively. Although there was no significant difference among the three groups but the thickest parenchyma was noted in DM group while the thinnest one found in HTN group.

The smallest mean of RR L was 9.4927 cm, noted in the age group 56-65 and the largest mean was 11.3366 cm, noted in age group 36-45. The study revealed that there was no significant difference in right renal length through age groups at p=0.41, as showed in Table 3,this finding agreed with [9], they found that right renal length was 10.68 ± 1.4 (p=0.56) without a significant change with age.

The smallest mean of LR L was 9.4270 cm, noted in the age group 66-75 and the largest mean was 11.9297 cm, noted in age group 36-45, with no significant difference at (p=0.36) as showed in Table 3.

The thinnest right parenchymal thickness 1.177 cm was noted in the age group 56-65 and the thickest one 2.116 cm was noted in the age group 66-75. No significant difference at p=0.16. The thinnest left parenchymal thickness 1.77 cm was noted in the age group 56-65 and the thickest one 3.17 cm was noted the age group 36-45 with significant difference at p=0.00, as showed in Table 3, that meant the left parenchymal thickness vary significantly with age and this result disagreed with [9]. Increased reduction in parenchymal thickness due to age was noted in the study carried out by [10]. The mean of right renal lengths were 10.0481 cm and 10.5282 cm for male and female respectively.

The mean of left renal lengths were 10.6037 cm and 10.7487 cm for male and female respectively. The study revealed that no significant difference in renal length (right and left) between male and female at p=0.06, p=0.59 for right and left respectively as in Table 4, this finding consistent with [11]; Some studies, however, show that renal length is greater in males than in females [12] and other study found that renal length was similar for both genders 9.82 cm in males and 9.88 cm in females. Also no significant difference noted in right or left parenchymal thicknesses between male and female at (p=0.11 and 0.12).

Renal length according to participant's height

The smallest mean of RR L was 8.9000 cm, noted in the height group 1.81-190 cm and the largest mean was 10.4967 cm noted in height group 1.61-170 cm. The smallest mean of LR L was 9.8500 cm, noted in the height group 1.40-1.50 cm and the largest mean was 11.1000 cm noted in height group 1.71-1.80 cm. The study revealed that, there was no significant difference among height groups at p=0.25 for right renal length and at p=0.43 for left renal length. The study showed that renal length did not correlate with height, this result agreed with [9] Table 5.

Parenchymal thickness according to participant's height

The thinnest right parenchymal thickness 1.400 cm was noted in the height group 1.40-1.50 and the thickest one 2.300 cm noted in the height group 1.91-2.0 cm. The study showed that no significant difference among height groups for right parenchymal thickness at p=0.41.This result disagreed with previous findings in [10,13,14]. The thinnest left parenchymal thickness 1.4500 cm was noted in the height group 1.40-1.50 cm and the thickest one 1.9067 cm was noted the height group 1.51-1.60 cm. The study showed that no significant difference among height groups for left parenchymal thickness at p=0.42. We observed that, the right parenchyma was thicker than the left Table 5 [15].

Limitations of the Study

• Insufficient sample size (66 patients) to detect the reduction in renal length and parenchymal thickness according to diabetes mellitus and hypertension impacts. It needs a scientific research center.

• Financial problem, sometimes the patients have no enough money to do all laboratory investigations for renal function.

• Difficulty in determination the duration of the disease exactly. Old people didn't remember the date of their attack by DM and HTN.

Conclusion and Recommendations

• The study concluded that there was no significant difference among the three groups DM & HTN, DM and HTN either in the right or left renal length, but the it showed that the longest renal length was noted in DM & HTN group and the shortest one in HTN group. The left kidney was slightly larger than the right one.

• The thickest right parenchyma was noted in DM group while the thinnest one found in HTN group with significant difference at p=0.03.

• The thickest left parenchyma was noted in DM group while the thinnest one found in HTN group with no significant difference.

• The thinnest left parenchymal thickness was noted in the age group 56-65 and the thickest one was noted the age group 36-45 with significant difference at p=0.00.

• DM & HTN associated with the longest renal length while DM associated with the thickest parenchyma and hypertension HTN associated with the shortest renal length and thinnest parenchyma.

The study recommends further investigations with a large numbers of patients to:

• Detect the impact of diabetes and hypertension on right parenchymal thickness.

• Detect the impact of age on the left parenchymal thickness.

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Table 1: Distribution of renal length according to participant's disease.

Variable	**Disease**	**Mean**	**Std D**	**p-value**
Right Renal length	DM&HTN	10.3686	0.9872	0.85
	DM	10.3867	1.49421	
	HTN	10.2	0.71181	
Variable	**Disease**	**Mean**	**Std D**	**p-value**
Left Renal Length	DM&HTN	10.8429	1.11284	0.29
	DM	10.7133	1.15441	
	HTN	10.3312	0.91485	

Table 2: Distribution of renal parenchymal thickness according to participant's disease.

Variable	**Disease**	**Mean**	**Std D**	**p-value**
Right Renal Parenchymal Thickness	DM&HTN	1.52	0.41002	0.03*
	DM	1.7667	0.26367	
	HTN	1.4562	0.27318	
Variable	**Disease**	**Mean**	**Std D**	**p-value**
Left Renal Parenchymal Thickness	DM&HTN	1.9086	0.74848	0.64
	DM	1.9133	0.28251	
	HTN	1.75	0.35214	

Table 3: Renal length and parenchymal thickness according to participant's age.

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		p -value
					Lower Bound	Upper Bound	
Rt parenchymal thickness	25-35	1	1.400	.	.	.	0.16
	36-45	8	1.763	0.2875	1.522	2.003	
	46-55	34	1.574	0.3127	1.464	1.683	
	56-65	17	1.406	0.4451	1.177	1.635	
	66-75	6	1.683	0.4119	1.251	2.116	
	Total	66	1.561	0.3654	1.471	1.650	
Lt parenchymal thickness	25-35	1	3.00	.	.	.	0
	36-45	8	2.88	0.354	2.58	3.17	
	46-55	34	2.38	0.493	2.21	2.55	
	56-65	17	2.06	0.556	1.77	2.34	
	66-75	6	2.50	0.548	1.93	3.07	
	Total	66	2.38	0.548	2.24	2.51	
RR L	25-35	1	8.7000	.	.	.	0.41
	36-45	8	10.4750	1.03060	9.6134	11.3366	
	46-55	34	10.4176	1.06557	10.0459	10.7894	
	56-65	17	10.0941	1.16965	9.4927	10.6955	
	66-75	6	10.6000	0.46904	10.1078	11.0922	
	Total	66	10.3318	1.05512	10.0724	10.5912	
LR L	25-35	1	9.6000	.	.	.	0.36
	36-45	8	10.9000	1.23172	9.8703	11.9297	
	46-55	34	10.5765	0.99333	10.2299	10.9231	
	56-65	17	11.0353	1.24446	10.3955	11.6751	
	66-75	6	10.2500	0.78422	9.4270	11.0730	
	Total	66	10.6894	1.08275	10.4232	10.9556	

Table 4: Relationship of renal length and parenchymal thickness with gender.

Variable	Gender	N	Mean	Std. Deviation	Std. Error Mean	p-value
Rt parenchymal thickness	Male	27	1.644	0.3523	0.0678	0.11
	Female	39	1.503	0.3674	0.0588	
Lt parenchymal thickness	Male	27	1.8963	0.41831	0.0805	0.12
	Female	39	1.7513	0.33156	0.05309	
RR L	Male	27	10.0481	1.2135	0.23354	0.06
	Female	39	10.5282	0.89441	0.14322	
LR L	Male	27	10.6037	1.15608	0.22249	0.59
	Female	39	10.7487	1.04021	0.16657	
	Female	39	114.364	24.09	3.85749	

Table 5: Relationship of renal length and parenchymal thickness according to participant's height.

Variable	Height	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		p-value
						Lower Bound	Upper Bound	
Rt parenchymal thickness	1.40-1.50	2	1.400	0.4243	0.3000	-2.412	5.212	0.41
	1.51-1.60	15	1.500	0.4018	0.1037	1.278	1.722	
	1.61-170	30	1.560	0.3125	0.0571	1.443	1.677	
	1.71-180	16	1.581	0.4167	0.1042	1.359	1.803	
	1.81-190	2	1.650	0.3536	0.2500	-1.527	4.827	
	1.91-2	1	2.300	.	.	.	.	
	Total	66	1.561	0.3654	0.045	1.471	1.650	
Lt parenchymal thickness	1.40-1.50	2	1.4500	0.07071	0.05000	0.8147	2.0853	0.42
	1.51-1.60	15	1.9067	0.38631	0.09975	1.6927	2.1206	
	1.61-170	30	1.7667	0.31984	0.05839	1.6472	1.8861	
	1.71-180	16	1.8875	0.46025	0.11506	1.6422	2.1328	
	1.81-190	2	1.6500	0.35355	0.25000	-1.5266	4.8266	
	1.91-2	1	1.5000	.	.	.	.	
	Total	66	1.8106	0.37340	0.04596	1.7188	1.9024	
RR L	1.40-1.50	2	9.3500	0.35355	0.25000	6.1734	12.5266	0.25
	1.51-1.60	15	10.4067	0.88436	0.22834	9.9169	10.8964	
	1.61-170	30	10.4967	0.94777	0.17304	10.1428	10.8506	
	1.71-180	16	10.2938	1.33190	0.33298	9.5840	11.0035	
	1.81-190	2	8.9000	1.13137	0.80000	-1.2650	19.0650	
	1.91-2	1	9.7000	.	.	.	.	
	Total	66	10.3318	1.05512	0.12988	10.0724	10.5912	
LR L	1.40-1.50	2	9.8500	0.07071	0.05000	9.2147	10.4853	0.43
	1.51-1.60	15	10.4000	0.9688	0.25014	9.8635	10.9365	
	1.61-170	30	10.6833	0.98053	0.17902	10.3172	11.0495	
	1.71-180	16	11.1000	1.39332	0.34833	10.3576	11.8424	
	1.81-190	2	10.8000	0.56569	0.40000	5.7175	15.8825	
	1.91-2	1	10.1000	.	.	.	.	
	Total	66	10.6894	1.08275	0.13328	10.4232	10.9556	