

Sonographic assessment of kidneys in patients with hypertension co-existed with diabetes mellitus and ischemic heart disease

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ABSTRACT

Background: Hypertension is one of the major world health problems. Ultrasonography plays a useful role in the assessment of morphological changes at the kidneys in hypertensive patients. **Aim:** To assess sonographic findings of the kidneys in hypertensive patients' co-morbidities with type 2 diabetes mellitus and ischemic heart disease (IDH). **Materials and Methods:** This was a prospective cross-sectional study involved 100 participants with primary hypertension selected by a method of simple convenient sampling. The patients were examined using ultrasonography to assess the sonographic findings of the kidneys. The renal length, corticomedullary differentiation (CMD), and renal artery diameters were assessed. Statistical Package for the Social Sciences (SPSS version 23.0) was used in data analysis. **Results:** The length of the right kidney was 8.9850 ± 1.01 cm and 9.48 ± 0.98 cm for the left kidney. Among the hypertensive patients, the incidence of hypertension was highest in housewives (27%) and students (23%) as compared with the other groups. The sonographic findings were 18% affected with simple renal cysts, 7% poor CMD, and the majority had normal kidneys. Significant correlation was found between age and sonographic findings of kidneys ($r = 0.21$, P value = 0.033). **Conclusion:** Simple renal cysts, poor CMD, and stenosis of renal arteries were most common sonographic findings in hypertension. Simple renal cysts had a significant association with hypertension.

Keywords: Corticomedullary differentiation, diabetes mellitus, hypertension, renal cysts, sonography

Introduction

Hypertension (HTN) is responsible for the development of kidney diseases (KD) and contributes to cardiovascular events such as heart failure, myocardial infarction, and stroke. The incidence of hypertension is increased in patients with KD.^[1]

Nowadays, diabetes mellitus (DM), and HTN has become the most common etiologies of end-stage renal disease (ESRD) in many countries.^[2-4] DM and HTN were reported to be responsible for >50% of cases of ESRD.^[4]

The presence of family history for DM, overweight, and obesity increases the probability of acquiring type 2 DM.^[5] The primary care plays a great role for DM and HTN and considered as one of the most effective strategy in reducing morbidity, disability, and premature mortality of both HTN and DM.^[6] Investigating the impact of HTN and DM on

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the kidneys is important for health planners, clinicians, and academics.

Ultrasonography (US) is the essential imaging method for evaluation of the morphological changes of the kidneys as it is easy to perform, cheap, and has no biological effects. In urology, the US frequently leads to an optimal final diagnosis with assessing the renal length, cortico-medullary differentiation (CMD), and the presence of renal cysts.^[7]

DM and ischemic heart disease (IHD) have an increased risk of KD. There was a close correlation between HTN and DM with cardiovascular disease (CVD), which are responsible for the leading cause of morbidity and mortality.^[8] Therefore, in these situations, early sonographic investigation for kidneys is necessary to avoid severe complications and provides useful information for prognosis and management. The study explored the findings of the kidneys in hypertensive patients in co-morbidity with DM and IHD. Most of the previous studies had demonstrated the impact of DM of kidneys without HTN and other complications such as CVD.^[9] Therefore, the study aimed to evaluate the sonographic findings of the kidneys in hypertensive in co-morbidity with DM and IHD.

Materials and Methods

This was a cross-sectional study performed at Khartoum State hospitals in Soba University hospital, Umdorman Military Hospital, and Sharq El-Niel, from first June 2014 to end of August 2016. A total of 100 hundred Sudanese participants diagnosed with essential hypertension confirmed in their records. They were selected using the method of simple, convenient sampling. The uncontrolled DM was defined as those who were not regular on diabetes medicines and did not follow the instructions given by their Doctors. Patients with IHD were diagnosed to have cardiac problems caused by narrowed coronary arteries, which supplied the heart muscle.^[8]

The controlled hypertension was considered as blood pressure below 140/90 mm Hg or, if the patient had diabetes or chronic renal disease, below 130/80 mm Hg.^[9] On the other hand, uncontrolled hypertension was considered as blood pressure >140/90 mm Hg.^[10] In the study sample, the participants were categorized into four groups; 55 cases have controlled HTN, 20 cases with diabetes mellitus (DM, type 2), 18 with IHD, 7 cases with IHD and DM. The last three groups were uncontrolled hypertensive, and they were compared to 55 controlled hypertensive patients in accordance with the sonographic findings.

The results of renal function test were classified as normal and abnormal; and so the echogenicity was classified into increased and normal. Renal function test (RFT) is considered abnormal when it exceeds the normal range of 0.49–1.15 mg/dl and 11.28–36.14 mg/dl for creatinine and blood urea nitrogen,

respectively.^[11] The clinical data were collected from the patients' records. The study was approved by the ethical committee of Alzaiem Alazhari University on February 2014.

The sonographic procedures

The sonographic investigation was performed using Mindray DC-N3 (Mindray, China) and Toshiba Nemio 20 (Toshiba, Japan). A 3.5 MHz curvilinear array probe with a variable focal zone was utilized. Patients were fasting 3–4 h to remove abdominal gases and then investigated in supine positions, following the protocol of renal ultrasound. The patients were scanned in the supine and oblique positions to demonstrate the kidneys. Each kidney was examined with a B-mode ultrasound in at least two planes- transverse and longitudinal sections to maintain the renal length and width for each kidney. The length was measured from upper to lower pole for each kidney. The average length of the kidneys was considered 8.5 up to 12cm; renal length lesser than 7 cm was considered as a small kidney. CMD was determined and qualitatively evaluated. Color Doppler imaging was utilized to explore for renal artery stenosis (RAS).

Statistical analysis

Data were entered and analyzed by utilizing the Statistical Package for the Social Sciences (SPSS), version 23. Descriptive statistics used mean \pm standard deviation (SD). Chi-square was used to analyze then to compare the sonographic findings with the groups of HTN, age groups, and results of RFT. Spearman correlation test was used to find the relationship between the sonographic findings and age groups and hypertension groups. The significant statistical value was lesser than 0.05.

Results

The study composed of 100 hypertensive patients. They were 51 males and 49 females. The average age was 41.4 ± 5 years, and the duration of hypertension was 7.73 ± 4.56 years [Table 1]. In a controlled group of hypertension, the number of males was 35 and 20 females, while in the uncontrolled group there were 16 males and 29 females. Males to female ratio was 1: 1. The incidence was higher in housewives than others (27%), then in students and teachers (23% and 22%, respectively), as summarized

Table 1: Demographic characteristics of the study population

Characteristics	Frequency/Mean \pm SD
Gender	
Male	51
Female	49
Age	40.4 \pm 5(years)
Duration of hypertension	7.72 \pm 3 (years)
Occupation	
House wives	27
Students	23
Teachers	22
Employee	17
Workers	11

Table 2: Association between sonographic findings in the kidneys and age of hypertensive patients

Age groups	Sonographic findings			Total	P	Spearman correlation (r)
	Normal	Simple renal cysts	Poor CMD			
< 20 years	14	8	0	22	0.033	-0.21*
20-40 years	21	2	7	30		
41-70 years	33	8	0	41		
> 70 years	7	0	0	7		
Total	75	18	7	100		

*Correlation is significant at the 0.05 level (two-tailed)

Table 3: Sonographic findings in the kidneys of hypertensive patients

Sonographic findings	Mean±SD/ frequency
Length of the right kidney	8.98±1.01 cm
Length of the left kidney	9.48±0.98 cm
Average renal length	9.23±0.97 cm
Normal kidneys	75
Simple renal cysts	18
Poor CMD	7
Renal artery stenosis	
Yes	2
NO	98

in Table 1. The mean right renal length is 8.98 ± 1.01 cm, and the mean left renal length is 9.48 ± 0.98 cm, measured as the longest bi-polar length obtained on a supine and posterior oblique positioning. The average was 9.23 ± 0.97 cm, which was taken from the two measurements. The most affected age group was 41–70 years. A significant correlation was found between age and sonographic findings ($r = 0.21$, P value = 0.033), as shown in Table 2. However, the prevalence of sonographic findings group increased as age advanced, such as simple renal cysts.

The sonographic findings were 2% stenosis of renal arteries, 17% simple renal cysts, 7% with poor CMD, and 75% revealed normal kidneys [Table 3]. A significant correlation was found between sonographic findings and the groups of hypertension (P value = 0.008), as shown in Table 4. Figure 1 summarizes the relationship of average renal length with the subclinical groups of hypertension.

We explored the association between renal echogenicity and results of RFT. There was a significant association between increased echogenicity and abnormal values of renal function test (P value < 0.001), as shown in Figure 2.

Discussion

Hypertension and DM are a significant risk factors affecting the kidneys and produced marked morphological changes, which may lead to renal failure.^[12] The present study explored the gross sonographic findings in hypertensive co-morbidity with DM and IHD.

In the present study, it was found that HTN with DM and IHD caused poor CMD, which is a landmark of chronic CKD.

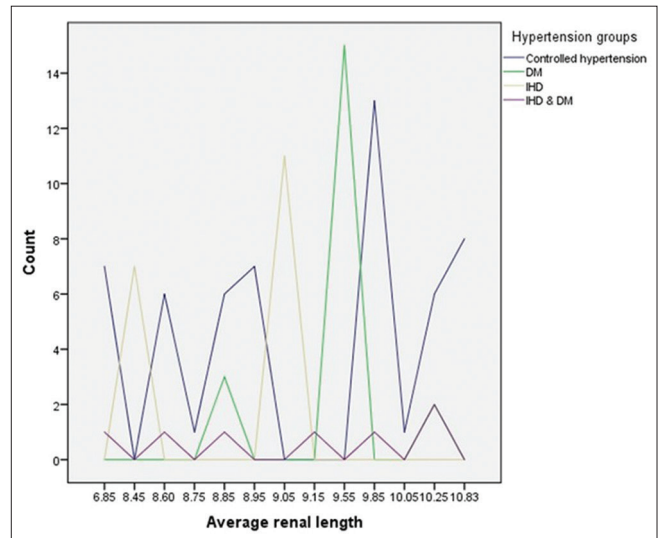


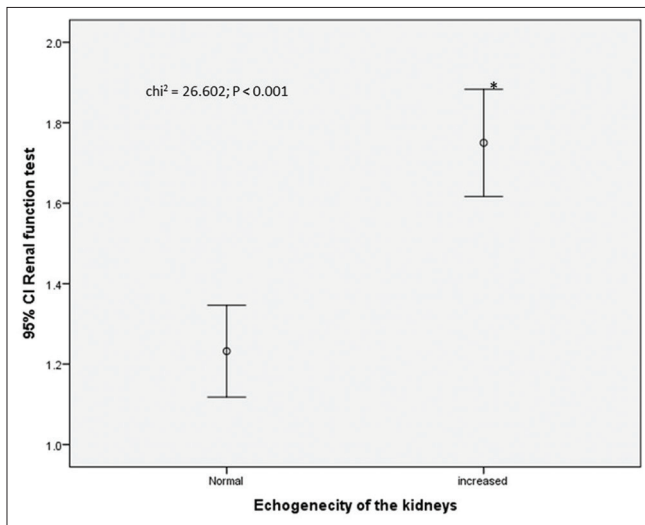
Figure 1: Measurement of average renal length in co-morbidities groups of hypertension

This result is consistent with previous studies that reported that the incidence of “HTN is higher among patients with CKD, progressively increasing with the severity of CKD”.^[13] CMD is a marker for assessing the presence of nephropathy. Our findings also consisted with Gareeballah *et al.* who found that CMD was mainly disturbed in acute parenchymal disease and lost in chronic end-stage parenchymal illness.^[14] A strong association was reported between HTN and diabetic nephropathy.^[13] Furthermore, the incidence of HTN varies with the etiology of CKD. Therefore, lack of CMD is attributed to increased cortical echogenicity. The increase in echogenicity is correlated with varieties of histopathological changes, such as medullary nephrocalcinosis, medullary fibrosis, medullary tubular ectasia, vascular congestion, and protein or urate deposits.^[15] Moreover, the increased echogenicity associated with abnormal values of RFT, as shown in this study.

In the current study, simple cortical cysts were significantly coincident with hypertension and correlated with age. In agreement with previous studies, it was reported that the incidence of renal cysts was common in adults above 50 years old and was significantly related to the prevalence of HTN.^[16,17] Another study performed by Hong *et al.*, found that the presence of simple renal was associated with a significantly increased prevalence of HTN.^[18] Furthermore, the effect of simple renal cyst on HTN was evident in aged persons.

Table 4: Association between hypertension groups and sonographic findings of the kidneys

Hypertension groups	Sonographic findings			Total	Contingency coefficient	P
	Normal	Simple renal cysts	Poor CMD			
Controlled hypertension	35 63.6%	16 29.1%	4 7.3%	55	0.384	0.008
DM	17 85%	0 0%	3 15%	20		
IHD	18	0	0	18		
IHD&DM	5 71.4%	2 28.6%	0 0%	7		
Total Percent (%)	75 75%	18 18%	7 7%	100 100%		

**Figure 2:** Association of renal function test with sonographic echogenicity of the kidneys in hypertensive patients

The current study found that RAS was prevalent in 2% in the study sample. RAS is narrowing of the renal arteries, is caused by the various entities, including atherosclerosis, vasculitis, neurofibromatosis, fibromuscular dysplasia, congenital bands, and extrinsic compression, and radiation.^[19] The present study analyzed the prevalence of RAS rather than the causes. Consistent with the findings of the present study, previous studies have reported that RAS accounted for 1–6% among patients with hypertension.^[20-22]

The findings of this study are important since DM and HTN accelerate kidney disease which in turn can lead to the progression of renal failure. Therefore, the community should be aware of the necessary of ultrasound examination for assessing the kidneys to avoid the severe complications.

Limitation of the study

The study faced significant problems that the sample size was not large enough. Second, we see it is challenging to separate the effect of DM and HTN on the kidneys as they were interchangeable. Further studies were recommended to confirm the initial results of this study.

Conclusion

Simple renal cysts and poor CMD were significantly positively associated with the incidence of HTN. Age has a significant association with the presence of simple cysts and the occurrence of CMD in hypertension. Sonographic evaluation of renal echogenicity is useful for determining the status of renal disease in hypertensive patients.

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Conflicts of interest

There are no conflicts of interest.

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