BRIEF REPORT

BRIEF REPORT: RENAL ULTRASOUND FINDINGS IN CHRONIC KIDNEY DISEASE – A SINGLE CENTRE STUDY FROM HAMBANTOTA DISTRICT OF SRI LANKA

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Abstract

Background

The aetiology of chronic kidney disease (CKD) has shown geographical clustering. Renal ultrasound (USS) is used as an aid to diagnose CKD, but USS features are known to vary with aetiology of CKD.

Objectives

To describe aetiological factors and USS features of CKD.

Methods

Renal USS was performed in adult patients diagnosed with CKD (n=100) and a control group (CG) with normal renal function (n=90). Demographic data, associated co-morbidities, serum creatinine values, renal length (RL), renal cortical echogenicity, and number of renal cysts were recorded. CKD severity was graded.

Results

Hypertension (38%) and diabetes (17%) were the commonest aetiological factors of CKD. Severity of CKD was as follows: 35% grade 3a, 39% grade 3b, 11% grade 2, and 15% grade 4. Mean RL of the CKD group (9.07cm; SD=0.84) was significantly lower ($p<0.001$) than the CG (9.83cm; SD=0.79). In the CG, the left kidney was longer than the right kidney (T=2.89; P=0.04); but no significant RL difference between both sides was seen in the CKD group (T=0.19; p=0.19). CKD patients (14%) had small kidneys with increased renal cortical echogenicity (95.7%); 55% in sonographic echogenicity grade 2, 20% grade 1, 30% grade 3, 3% normal echogenicity, and 2% grade 4. RL progressively decreased with CKD severity.

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Renal cysts were prevalent in the CKD group (34%). Compared to diabetics (5.8%), small kidneys were more frequently found in hypertensive patients (21.2%).

Conclusion

Hypertension and diabetes being the most common aetiological factors of CKD had shown an influence on renal length. Renal length and the echogenicity varied with the severity of CKD.

Keywords: Renal ultrasound, chronic kidney disease, Sri Lanka

Introduction

Parallel to the global epidemic of chronic kidney disease (CKD), the CKD prevalence in Sri Lanka has also increased[1]. The rising prevalence of CKD in Sri Lanka is multifactorial. Firstly, there is the epidemical spread of non-communicable diseases such as diabetes and hypertension[2]. Secondly, the increasing diagnosis of a novel disease entity called "chronic interstitial nephritis in agricultural communities" (CINAC; previously known as CKDu). Thirdly, improvement in CKD diagnosis with sensitive diagnostic tests has also contributed to the rising prevalence[1]. Besides the uniform geographical distribution of most non-communicable diseases, CINAC has shown an apparent geographical clustering. CINAC clusters are pronounced in the North Central Province while having a low prevalence in Uva and North Western Provinces[1,2,3]. The epidemical spread of CINAC in the North Central Province has been attributed to dry weather and the widely spread rice cultivating areas that utilize the feeds from a network of water reservoirs. Hambantota district is located in the Southern province of Sri Lanka. It shares similar climatic and agricultural features to the North Central Province[4]. Thus, the inhabitants of Hambantota district are at a theoretical risk of getting CINAC.

The diagnosis of CKD is made by evaluating both clinical and investigation findings. The investigations using to diagnose CKD range from biochemical, histological to imaging techniques[5]. Among the imaging techniques, ultrasonography is abundantly used to diagnose and to monitor the progression of CKD. The retroperitoneal position of the kidneys allow effortless ultrasonographic assessment with minimum interference of bowel gas. Additionally, ultrasonographic renal assessment is popular due to free availability, non-invasive nature and lack of exposure to ionizing radiation[6]. However, the ultrasonographic appearance of kidneys may vary with the aetiological factors of CKD[3]. Considering the geographical variations in aetiological factors of CKD[1], we hypothesize the possibility of geographic variation in renal ultrasound features of CKD.

Besides having a high susceptibility to CKD, compared to the rest of the dry zone, the disease burden is overlooked in Hambantota district of Sri Lanka. Hence, this study was focused on evaluating etiological factors and ultrasonographic features of CKD in a cohort of diagnosed CKD patients who presented to a single health care centre in Hambantota district.

Material and methods

This descriptive, cross-sectional, observational study was conducted at the Radiology unit of Base Hospital Tissamaharama, from March 2017 to March 2018. Prior to data collection, ethical approval was obtained from the ethical review committee of Faculty of Medicine, University of Ruhuna (ethical approval reference number 19.12.2016:3.8). Informed written consent was obtained from all the study subjects. The disease group and control groups were selected as follows: all the diagnosed CKD patients referred to the Radiology department for ultrasound examination during the study period were recruited as the CKD group (n=100); those who presented for ultrasound examination for non-renal cause (with normal Scr values and not diagnosed to have CKD) were recruited as the control group (n=90). The control group was selected to match the age range and the gender of the CKD group. Following patients were excluded from the study: those below 18 years; history of renal surgery; currently diagnosed to have either acute renal insufficiency or on renal replacement therapy (haemodialysis, peritoneal dialysis, renal transplantation); diagnosed fatty liver; known liver disease; unconsented patients. CKD diagnosis was made by the physician using the standard guidelines: presence of abnormal renal function (eGFR < 60ml/min/1.73m^2) and or abnormal renal markers (proteinuria or abnormal cells in urine analysis, renal abnormality found in renal biopsy) for three months duration[7]. If the patient was above 70 years, correction for age-related eGFR reduction was considered in the diagnosis of CKD. For this serum electrolytes and urine analysis were evaluated; the diagnosis was made only if the electrolyte or urine analysis were abnormal, in the background of eGFR <60ml/min/1.73m^2 [8]. eGFR was calculated using the serum creatinine value and the height of the patient using the MDRD formula [7]. CKD was graded using eGFR values, according to standard guidelines[7]. Age, gender, associated co-morbidities, height, and weight of the subjects were recorded.

The experienced Radiologist, who has performed the ultrasound scans (USS) was blind to the patients serum creatinine values. Renal assessment was done using 3.5 MHz curved array transducer of the Mindray DC 60 ultrasound unit. The patients were hydrated and with full urinary bladder during assessment. Maximum pole to pole length of the kidneys were measured to the nearest millimeter. Renal echogenicity grade[9,10] and number of renal cysts were recorded.

Statistical analysis

Data were analyzed using IBM statistics (version 25). Continuous variables were reported as means and standard deviations; categorical variables were reported as percentages. The variables were compared for significance among groups using independent and paired sample T-tests. The p-value <0.05 was considered as statistically significant.

Results

Diagnosed CKD patients (n=100) and a control group (n=90) with normal renal function were studied. The gender distribution of the study group was as follows: 30% females and 70% males in the CKD group; 37% females and 63% of males in the control group. Mean height of the study population was 159.1cm (SD=9.1). Both CKD and control groups were in 50 – 90 year age arrange. The mean age of the CKD group was 65 years (SD=8.5), and the mean age of the control group was 61 years (SD=8.1). The majority of CKD patients were in 60 to 69 year age group (49%), and the rest were in 50 to 59 year (12%) and 70 to 90 year (39%) age groups.

Most CKD patients were from Tissamaharama area (44%). The others were from Kirinda (17%), Debarawewa

(13%), Weerawila (9%), Lunugamwehera (8%) and Katharagama (4%). Forty per cent (40%) of all male CKD patients were farmers, while 73% of females were housewives. The associated co-morbidities of CKD included hypertension (38%), diabetes (17%), and concomitant diabetes and hypertension (27%). No associated co-morbidity was reported in 12% of patients.

Table 01 depicts the biochemical investigation findings and the renal ultrasound parameters of the study population. Compared to the control group, the CKD group had significantly higher serum creatinine (T=15.2, p<0.0001) and lower eGFR values (T=23.1, p<0.0001). The majority of patients were in CKD grade 3a (35%) and grade 3b (39%), while the others were in grade 2 (11%) and grade 4 (15%). The mean renal length of the CKD group (9.07 cm; SD=0.84) was significantly lower (p<0.001) than the control group (9.83 cm; SD=0.79). In both CKD (T=3.5, p<0.001) and control groups (T=4.2, p<0.001), the mean renal length of the females was lower than that of males. Though the left kidney was longer than the right kidney in the control group (T=2.89; P=0.04), no significant length difference was found (between right and left kidneys) in the CKD group (T=0.19; p=0.19). Fourteen per cent (14%) of CKD patients had small kidneys, while 86% had normal-sized kidneys. Figure 1 depicts the renal lengths of the control and CKD groups, according to CKD severity. In severe CKD, the renal length had decreased progressively.

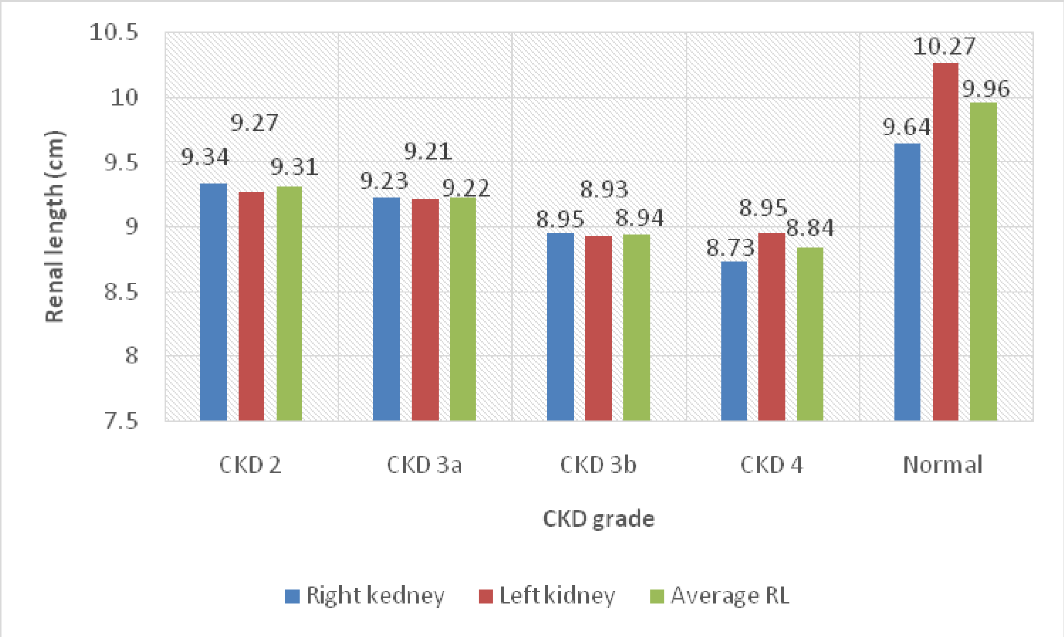
Table 2 describes the renal cortical echogenicity grading of the study population. Unlike the control group who had normal renal cortical echogenicity (100%), the majority of CKD patients had increased renal cortical echogenicity (95.7%). Sonographic grade 2 renal cortical echogenicity was most common (55%), followed by grade 1 (20%), grade 3(20%), normal (3%), and grade 4 (2%) renal cortical echogenicities.

Simple renal cortical cysts were found in both study groups (CKD and the control). Compared to the control group (4%), renal cortical cysts were more prevalent in the CKD group (34%). Though the renal cysts were commonly bilateral in CKD group - 19% bilateral;10% left; 5% right renal cysts in CKD group - left renal cysts were common in the control group (3.3%). Only 0.7% of the control group subjects had bilateral renal cysts.

Table 01: Comparison of biochemical and renal ultrasound parameters of the study groups

	CKD group		**Control group**	
	Male (n=70)	**Female (n=30)**	**Male (n=57)**	**Female(n=33)**
Age (years)	68 (7.9)	67 (9.3)	60 (7.9)	62 (8.5)
Scr (mg/dl)	1.91 (0.7)	1.79 (0.5)	0.94 (0.1)	0.79 (0.08)
eGFR (umol/l)	46.4 (12.0)	36.2 (7.8)	84.9(10.9)	79.6 (8.9)
RK length (cm)	9.13 (0.84)	8.90 (0.99)	9.85 (1.09)	9.35 (0.87)
LK length (cm)	9.14 (0.81)	8.91 (0.99)	10.15(1.02)	9.45 (0.82)

CKD - chronic kidney disease, Scr - serum creatinine, eGFR - estimated glomerular filtration rate,
RK - right kidney, LK - left kidney



CKD - chronic kidney disease

Figure 1: Renal lengths in health and in chronic kidney disease

Table 02: Renal echogenicity grades in chronic kidney disease group and the control group

		CKD group		Control group	
		Male(n=70)	**Female (n=30)**	**Male (n=57)**	**Female(n=33)**
RC echogenicity	Grade 0	03 (4.3%)	0 (0%)	57 (100%)	33 (100%)
	Grade 1	12 (17.1%)	8 (26.7%)	-	-
	Grade 2	40 (57%)	15 (50%)	-	-
	Grade 3	14 (20%)	6 (20%)	-	-
	Grade 4	1(1.5%)	1(3%)		

CKD - chronic kidney disease, RC - renal cortical

A significant renal length difference was observed among diabetes, hypertensive and concomitant diabetic-hypertensive groups: renal length of diabetes group was 9.61 cm (SD=0.82; T=47.0; $p<0.001$); hypertensive group was 8.71 cm (SD=0.74; T=67.3; $p<0.001$); concomitant diabetic- hypertensive group was 9.27 cm (SD=0.86; T=55.2; $p<0.001$). No significant renal echogenicity difference was found according to the studied co-morbidities ($p<0.05$). Among the study population, none were reported to have an enlarged kidney (>11.4 cm). However, small kidneys (<8.25cm) were found in 5.8% of the people with diabetes, 21.2% of the hypertensive patients and 23.1% of concomitant diabetic-hypertensive patients.

Discussion

The current study has fulfilled the timely need of describing ultrasound features of CKD in a population from Hambantota district of Sri Lanka. In this study, we found, hypertension and diabetes as common associated co-morbidities of CKD. Though the renal length changed with the associated co-morbidity of CKD, the renal cortical echogenicity did not change. However, the severity of CKD had an impact on renal length and the echogenicity: renal length decreased, and renal cortical echogenicity increased with the severity of CKD.

Similar to the current study, a study from the Western Province of Sri Lanka reported hypertension and diabetes as the major causative factors of CKD[11]. In agreement with the current study, a Sudanese study reported hypertension and diabetes as the major causative factors of CKD: diabetes in 7.77%; hypertension in 33% and both diabetes and hypertension in 4.85% [12]. Diabetic nephropathy (31%) was the major recognized aetiological factor of CKD in India, where diabetic nephropathy was closely followed by chronic kidney disease of unknown aetiology (CINAC-16%), glomerular nephritis (14%) and hypertensive nephropathy (13%)[13]. Collectively, in most geographical regions, non-communicable diseases such as diabetes and hypertension are important aetiological factors of CKD.

In this study, we could not identify many patients without a secondary cause for CKD. The methodology used to define CKD cases (serum creatinine based CKD diagnosis) would underestimate the actual CKD disease burden and the burden of CINAC in Hambantota district. Novel diagnostic methods, such as creatinine normalized urinary KIM-1 and NAGL (measured using ELISA), are considered to be more sensitive biomarkers in diagnosis of CINAC[14]. Therefore, the prevalence of CINAC in Hambantota district needs to be evaluated using sensitive diagnostic markers.

We found a reciprocal relationship between renal sizes and the CKD severity. Though enlarged kidneys were not reported, small kidneys were found in CKD patients. In this study, a small kidney was defined if the renal length was <2SD of the mean renal length of the control group; that is <8.25 cm. In contrast to Khadka at al., who reported 21% small kidneys (<8cm)[10], we found only 14% small kidneys. In agreement with Khadka et al., another study reported 35% small kidneys among CKD patients[15]. In this study, a large kidney was defined if it was >2SD of the mean renal size of the control group: >11.4 cm. In contrast to our findings, a Sudanese study has shown large kidneys (>12.5 cm) in 2-3.9% of diabetic patients[16]. The different proportion of CKD patients with small kidneys among populations would reflect the differences in definitions of the normal renal length, as well the influence of the aetiology of CKD on renal length. In contrast to the current study (small kidneys in 5.8% of diabetic patients and 23.1% of diabetic hypertensive patients), a Sudanese study reported small kidneys (<8.5 cm, 20–22.4%) among diabetic patients[16]. This study is in agreement with a Turkish study which reported small kidneys in hypertensive patients[17]. Thus, the association between selected aetiological factors and renal length has been confirmed by the current study for a Sri Lankan population.

Similar to findings of this study, Singh A et al. have reported sonographic echogenicity grade 2 (42%) as the frequent echogenicity grade, that was followed by grade 1 (35%), grade 3 (16%) and grade 4 (7%)[15]. In contrast, Siddappa et al [grade - (48%), grade 2 (35%), grade 3 (11.7%) and grade 4 (5%)] and Khadka et al. [grade 1 (32%), grade 2 (31%), grade 3 (20%) and grade 4 (16%)] have reported high frequency of grade 1 and grade 4 renal cortical echogenicities[10,18]. The prevalence of renal cysts (34%) among the studied

CKD subjects was compatible with the Nepal CKD population (36%)[10].

Though this study is a pioneer study to describe renal ultrasound features for the Sri Lankan CKD population, the study has several limitations. Since the study sample was obtained from a single health care centre, findings of this study would not represent the actual geographical distribution of CKD in the Hambantota district. Therefore the findings cannot be generalized to the Sri Lankan population. Though we have evaluated the association between associated co-morbidities and the ultrasound features of CKD, it would be more appropriate to evaluate the association between the aetiology and ultrasound features of CKD if the aetiological factor could be defined.

In conclusion, non-communicable diseases such as hypertension and diabetes were the most frequent associated co-morbidities of CKD. According to the severity of CKD, the renal length progressively decreased and the renal cortical echogenicity progressively increased. Additionally, a clear association has been demonstrated between aetiological factors of CKD (hypertension and diabetes) and renal length. Also, the ultrasound findings in CKD patients from Hambantota district are compatible with available literature from other countries.

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