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USG findings in chronic kidney disease: A institution based study

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Abstract
Background: Geographic clustering has been discovered in the etiology of chronic kidney disease (CKD). The use of renal ultrasound (USG) to diagnose CKD is common, but USG features are known to differ depending on the etiology of CKD.
Objectives: The aim of this study was to identify the etiological factors and USG features of CKD.
Methods: Ultrasonogram was done in adult patients diagnosed with CKD (n=100) and a control group (CG) with normal renal function (n=90). The following information was collected: demographics, related co-morbidities, serum creatinine levels, renal length (RL), renal cortical echogenicity, and the number of renal cysts and the severity of CKD was assessed.
Results: The most important etiological factors of CKD were hypertension (38%) and diabetes (17%). CKD severity was as follows: 35% grade3a, 39% grade3b, 11% grade2 and 15% grade4. Mean renal length 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% grade4. Renal length progressively decreased with CKD severity. Renal cysts were prevalent in the CKD patients (34 %). Small kidneys were observed more commonly in hypertensive patients than in diabetics (5.8%). (21.2%).
Conclusion: The most important etiological factors of CKD were hypertension and diabetes and had an effect on renal length. Renal length and the echogenicity were varied with the severity of CKD.

Keywords: Ultrasonogram (USG), chronic kidney disease, Kulasekharam

Introduction
The diagnosis of CKD is made after a thorough examination of both clinical and laboratory 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 by assessing parameters such as duration, cortical echogenicity, and corticomedullary demarcation. The position of the kidneys being retroperitoneal, allows effortless ultrasonographic assessment with bowel gas minimum interference. 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 etiological factors of CKD [3]. Considering the geographical variations in etiological factors of CKD [1], we hypothesize the possibility of geographic variation in renal ultrasound features of CKD.
Despite the fact that ultrasonography is a safe, accurate, noninvasive, and widely available imaging modality, the optimum ultrasound parameter for evaluating and monitoring renal function in CKD remains unknown. Although a few experimental studies have looked at renal cortical and parenchymal thicknesses, none have looked at the relationship between them and etiological variables or the severity of CKD. As a result, ultrasonography measurements such as renal cortical and parenchymal thicknesses have limited practical applicability in diagnosis.
Considering the possibility of geographical and ethnic differences in renal USG parameters, an accurate understanding of ethnic-specific variations for both healthy and diseased individuals is important. We predicted that measuring renal cortical and parenchymal thicknesses, rather than traditional parameters like renal length, would be a better way of determining early renal function impairment.

The likelihood of comorbidity-related variations in renal cortical thickness (RCT) was also considered. The primary objective of this study was to determine the diagnostic performance of ultrasonography variables (such as absolute RL, relative RL, RCT, and renal PT) in the diagnosis of early and advanced stages of CKD. We also assessed at the renal ultrasonic parameters to see if there were any associations between renal function and ultrasonic parameters (absolute RL, relative RL, RCT, and renal PT); RCT and the severity of CKD; and RCT and common comorbidities (such as etiological factors of CKD).

Material and methods

This descriptive, cross-sectional, observational study was conducted in Department of Radiodiagnosis, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari district, Tamil Nadu, from January 2019 to January 2020. After obtaining approval from ethical committee, informed written consent was obtained from all the study subjects. The disease and control groups were chosen as follows: the CKD group (n=100) consisted of all diagnosed CKD patients referred to the Radiology department for ultrasound examination during the study period; the control group (n=90) consisted of those who presented for ultrasound examination for non-renal reasons (with normal S. Creatinine values and not diagnosed with CKD). 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 prior renal surgery; currently diagnosed to have either acute renal insufficiency or on renal replacement therapy (hemodialysis, 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 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 [28]. 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 ACUSON X300 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

IBM statistics were used to assess the data (version 25). The means and standard deviations of continuous data were recorded, while percentages were reported for categorical variables. Using independent and paired sample T-tests, the variables were examined for significance between groups. Statistical significance was defined as a p-value of less than 0.05.

Results

A total of 100 people with CKD were studied, as well as a control group of 90 people with normal renal function. The study group's gender distribution was as follows: In the CKD group, 30% of the women were female and 70% of the men were male; in the control group, 37% of the women were female and 63% of the men were male. The average height of the participants in the study was 159.1cm (SD=9.1). Both the CKD and control groups were 50 to 90 years old. The CKD group was 65 years old on average (SD=8.5), while the control group was 61 years old on average (SD=8.1). The bulk of CKD patients (49%) were in the 60 to 69 year age group, with the remainder in the 50 to 59 year (12%) and 70 to 90 year (39%) age groups. Farmers made up 40% of all male CKD patients, whereas housewives made up 73% of female CKD patients. Hypertension (38%) and diabetes (17%) were the most common co-morbidities of CKD, as were diabetes and hypertension co-existing (27%). In 12% of patients, no associated co-morbidity was reported.

The biochemical investigation findings and renal ultrasonography parameters of the study population are shown in Table 1. The CKD group showed substantially higher serum creatinine (T=15.2, p0.0001) and lower eGFR values (T=23.1, p0.0001) than the control group. The majority of patients had CKD grades 3a (35%) and 3b (39%) whereas the others had grades 2 (11%) and 4 (4%). (15 %). The CKD group's mean renal length (9.07 cm; SD=0.84) was substantially smaller (p0.001) than the control group's (9.83 cm; SD=0.79). Females had lower renal lengths than males in both the CKD (T=3.5, p0.001) and control (T=4.2, p0.001) groups. Despite the fact that the left kidney was longer than the right kidney in the control group (T=2.89; P=0.04), there was no significant length difference (between the right and left kidneys) in the CKD group (T=0.19; p=0.19). Small kidneys were found in 14% of CKD patients, while normal-sized kidneys were found in 86%. The renal lengths of the control and CKD groups are depicted in Figure 1 according to the severity of CKD. Renal length had gradually decreased in patients with severe CKD.

The study population's renal cortical echogenicity was grade d in Table 2.

The majority of CKD patients showed increased renal cortic al echogenicity (95.7%), as opposed to the control group, which had normal renal cortical echogenicity (100%).

Sonographic grade 2 renal cortical echogenicity was the mo st common (55%) followed by grade 1 (20%), grade 3 (20), normal (3%), and grade 4 (2%) renal cortical echogenicity.

In both study groups, simple renal cortical cysts were discovered (CKD and the control). Renal cortical cysts were more common in the CKD group (34 %) than in the control group (4 %). Though bilateral renal cysts were more common in the CKD group (19% bilateral; 10% left; 5% right in the CKD group), left renal cysts were more common in the control group (3.3 %) and 0.7% of the control group subjects only had bilateral renal cysts.

Table 1: 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

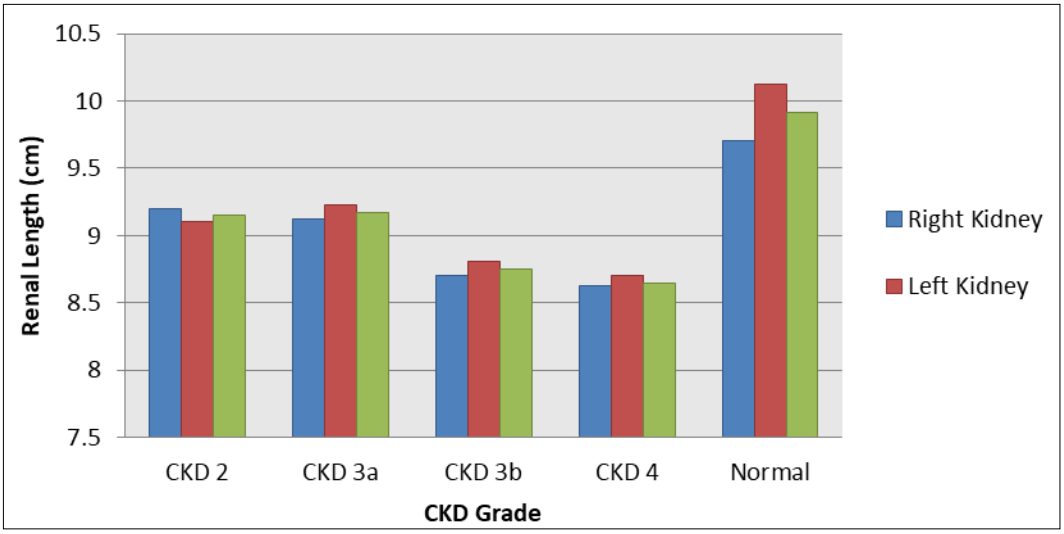

Fig 1: Kidney length in healthy and in CKD individual

Table 2: 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

The renal length of the diabetes, hypertensive, and concomitant diabetic-hypertensive groups differed significantly: the renal length of the diabetes group was 9.61 cm (SD=0.82; T=47.0; p0.001), the hypertensive group was 8.71 cm (SD=0.74; T=67.3; p0.001), and the concomitant diabetic-hypertensive group was 9.27 cm (SD=0.86; T=55.2; p<0.001). There was no significant difference in renal echogenicity across the examined co-morbidities (p0.05). No person reported having an enlarged kidney (>11.4 cm) within the study sample. Small kidneys (8.25cm) were detected in 5.8% of diabetics, 21.2 % of hypertensive patients, and 23.1% of concomitant diabetic-hypertensive patients.

Discussion

Our study has fulfilled the need of describing USG features of patients with CKD. Hypertension and diabetes were discovered to be prevalent co-morbidities of CKD in this study. Although the renal length changed as a result of the CKD co-morbidity, the renal cortical echogenicity remained unchanged. However, the severity of CKD had an effect on renal length and echogenicity: as the severity of CKD increased, renal length reduced and renal cortical echogenicity increased.

We could not find many patients in this study without a secondary cause for CKD. The mechanism employed to define CKD cases (serum creatinine-based CKD diagnosis) would understate the true burden of CKD disease and CINAC. In diagnosis of CINAC [14], In novel diagnostic methods, such as creatinine normalized urinary KIM-1 and NAGL (measured using ELISA), are considered to be more sensitive biomarkers. So, the prevalence of CINAC has to be evaluated using these sensitive diagnostic markers.

We found an inverse correlation between renal size and the severity of CKD. Small kidneys were identified in CKD patients, while no enlarged kidneys were observed. A small kidney was classified in this study as one whose renal length was less than 2SD of the control group's mean renal length, which was 8.25 cm. In our study we found only 14% small kidneys, this is in contrast to Khadka *et al.*, who reported 21% small kidneys (<8cm) [10], 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. The fact that different populations have varied proportions of CKD patients with small kidneys could be due to discrepancies in definitions of normal renal length, as well as the influence of CKD etiology on renal length. In

contrast to the current study (small kidneys in 5.8% of diabetes patients and 23.1 % of diabetic hypertensive patients), another study found small kidneys in 16 diabetic patients (8.5 cm, 20–22.4%). This research backs up a Turkish study that found undersized kidneys in hypertension patients [17].

The current population analysis has confirmed the association between specified etiological factors and renal length.

In correspondence to findings of this study, Singh A *et al*. have reported grade 2 (42%) as the frequent sonographic echogenicity, followed by grade 1 (35%), grade 3 (16%) and grade 4 (7%) [15]. This is in contrast with 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 renal cortical echogenicities of grade 1 and grade4 in high frequencies [10, 18]. The prevalence of renal cysts (34%) among the studied CKD subjects was (36%) [10].

Despite the fact that this is a pioneer study to describe renal ultrasonography features in the CKD population, it has a number of limitations. Because the study sample was drawn from a single health-care facility, the results may not reflect the true regional distribution of CKD. Therefore the findings cannot be generalized. Though we have evaluated the association between associated co-morbidities and the USG features of CKD, it would be more accurate to evaluate the association between the etiological factors and USG features of CKD if the etiology could be defined.

In conclusion, non-communicable disorders like hypertension and diabetes were found to be the most common CKD co-morbidities. The renal length reduced as the severity of CKD rose, whereas the renal cortical echogenicity increased. Furthermore, a clear link has been established between CKD etiological variables (hypertension and diabetes) and renal length. Also, the USG findings in CKD patients are concordance with literature available from other countries.

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