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Utility Of Ultrasonography Findings For The Diagnosis Of Chronic Kidney Disease And Its Association With Serum Creatinine

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Abstract

Introduction: In the recent era of medicine after multiple diagnostic tools and treatment modalities many people still suffer from chronic kidney disease (CKD). Early detection can save further damage to kidneys and dialysis or kidney transplant can be avoided.

Aim: The present study aimed to compare and evaluate the association between radio diagnostic technique ultrasonography with routine biochemical marker serum creatinine for kidney function.

Results: The study observed a significant association between circulatory serum creatinine levels and renal cortical echogenicity in CKD patients. The serum creatinine levels were elevated as the grade progresses [1.259 (±0.048) < 1.766 (±0.132) < 2.543 (±0.578) < 3.326(±0.327) < 5.154 (±0.639) < 2.243 (±1.052)]. The present study evaluated a statistically significant association of circulatory creatinine concentration with ultrasonographical parameters like parenchymal thickness, longitudinal length, cortical thickness, and degree or grade of cortical echogenicity. Further, it was observed that the highest statistical association was reported between the circulatory creatinine levels and cortical echogenicity degree or grade. **Conclusion:** The present study concluded that ultrasonography is one of the effective non-invasive, reliable, easy, and cost-effective techniques for the diagnosis of CKD. The grading of cortical echogenicity plays an important role, which is irreversible, and it might be considered a standard parameter for the assessment of the functioning of the kidneys.

Keywords: Chronic Kidney Disease (CKD), Ultrasonography (USG), Parenchymal Thickness, Longitudinal Size, Cortical Thickness, Echogenicity grade and serum creatinine

Introduction

Chronic kidney disease (CKD) is defined as an alteration in the serum creatinine concentration from some months to years. The severity of renal impairment is determined by the glomerular filtration rate (GFR), which has been below 60 ml/min per 1.7 m^2 over the period of 3 months and above [1, 2].

Ultrasound is a very cost-effective and easy-to-use technology because it is a non-invasive, low-cost

investigation modality that provides the anatomical features required to identify kidney illnesses without subjecting the person to radiation or contrast [3-5]. All of these elements support the early diagnosis and forecast the chances of abnormal renal function tests required for treatment decision-making. Beyond its value in describing a dilated collecting system, sonography can measure renal length, thickness, and echogenicity [6].

These specifics aid to determine the extent of renal parenchymal injury and whether or not it is repairable [7, 8], as well as the choice to do a renal biopsy [9]. The research found that 67% of CKD cases had abnormal sonographic results [10].

Interstitial fibrosis and glomerulosclerosis have higher echogenicity due to the presence of collagen [11]. Interstitial inflammation may also increase with an increase in echogenicity [12, 13]. Renal parenchymal echogenicity can be accurately measured and is a conventional tool for a small group of people [14]. It was discovered that glomerular sclerosis or tubular necrosis significantly correlates with renal length or cortical echogenicity [15].

Numerous methods, such as measuring renal length, volume, and cortical thickness, can be used to ascertain renal morphology. Renal length and cortical thickness can also be used to assess renal function, and based on this information, crucial clinical decisions can be made. To determine the course of renal illness or its normality, serial sonographic evaluations are therefore performed [16]. Although the longitudinal length of the kidney is sufficient in people with normal kidney function, renal parenchymal volume assessment is extremely accurate and precise in advanced renal failure patients [17].

Therefore, ultrasonography is a useful technique for determining renal insufficiency and disease development. Our study's objectives were to examine the relationship between renal echogenicity and circulatory levels of serum creatinine and the association of echogenicity of the renal tissue to determine the stage of CKD.

Materials And Methods:

This present study was carried out on CKD patients from the Navi Mumbai region. This study included a total of 226 CKD patients. All involved CKD patients were referred for a renal predetermined ultrasound and their creatinine level was measured on the same day as the scan was taken into account.

The following inclusion criteria were adapted for recruitment of the patients included in the study: newly diagnosed CKD examination, patients with CKD according to definition, patients with advanced CKD-like stages 3,4,5 and with GFR 60 ml/min which was calculated by the Modification of Diet in Renal Disease (MDRD) equation, and patient aged > 30 years (both genders). The current study excluded individuals with existing acute renal injury, kidney transplant recipients, patients undergoing hemodialysis, patients with existing fatty liver and chronic liver diseases, and patients with a single kidney.

With a sector curved array transducer (3.5–5 MHz) and a typical B Mode grey scale ultrasonography, the liver and kidneys were imaged. For correction of a low tissue harmonic imaging with speckle reduction was used to lessen interobserver bias and evaluate the parenchymal echogenicity of the liver and kidney. Manual adjustments were made to time gain compensation and gain. A portion that was visually assumed to represent the longest longitudinal section was used to measure the longitudinal length. In a region perpendicular to the longitudinal axis of the kidney, as determined by longitudinal imaging. The ultrasonic probe does not have to remain perpendicular to the skin at all times. The transverse segment was, set relatively far from the kidney's hilum while remaining clear of the pelvis.

IBM (SPSS version 23) was used to analyze the statistical data. Age was estimated using the mean and standard deviation; gender and echogenicity were calculated using the mean parenchymal thickness, mean longitudinal size, frequency, and percentages. One-way analysis of variance (ANOVA) was used to calculate the statistical analysis. By using correlation coefficient analysis, the link between serum creatinine and ultrasonographic variables was evaluated. Statistics were considered significant for P values under 0.05.

Results:

In this study, 226 individuals with chronic kidney disease were included. Out of 226, 24% of the patients were under the age of 45, 40 % were from

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the age group 46- 60, and the remaining 36 % were > 60 years. The patients' average age was 56.12±12.37 years. The data represented in Table 1 display their average circulatory levels of creatinine, parenchymal thickness, longitudinal length, and cortical thickness.

Sixty-three percent of the 226 patients were men and thirty-seven percent were women. The Level of the Grades was considered as 1-4. Level of the Grades 0-4 ultrasonography results for renal parenchymal alterations were reported. 62 patients (27%) had parenchymal changes of Grade 0, 59 patients (26%) had parenchymal changes of Grade 1, 41 patients (18%) had parenchymal changes of Grade 2, 36 patients (16%) had parenchymal changes of Grade 3, and 28 patients (13%) had parenchymal changes of Grade 4.

Table 2, showed the comparison of Circulatory Creatinine with Renal Cortical Echogenicity and further showed that the serum creatinine levels were elevated as the grade progresses (Grade 0< Grade 1< Grade 2< Grade 3< Grade 4< Grade 5), it was maximum in Grade-5 which suggest that the Serum creatinine levels were directly proportional to the damage to the kidneys.

Table 3, indicates that there was a significant degree of positive association observed with the parenchymal thickness and circulatory creatinine concentration (r=0.421). An inverse statistical association was observed between the length of the kidneys with the concentration of circulatory creatinine concentration (r= -0.509). It suggests the importance of renal length as a diagnostic non-invasive tool and the role of USG. Further, the study observed a significant inverse association between cortical thickness and circulatory creatinine concentration (r= -0.761), and the most significant association was seen between the grade of the cortical echogenicity and circulatory concentration of creatinine (r=0.947**).

Tables

"Table 1 : Descriptive Statistics of the Characteristics of the Patients"

Variables	**Mean (± SD)**
Age	56.12 (±12.37)
Circulatory creatinine (mg/dl)	2.33 (±1.09)
Parenchymal thickness	4.53 (±0.67)
Longitudinal length (cm)	9.86 (±0.91)
Cortical thickness	0.93 (±0.239)

"Table 2 : Comparison of Circulatory Creatinine with Renal Cortical Echogenicity"

Grade of Echogenicity	**No. of Participants**	**Circulatory Creatinine (mg/dl)**
	(n)	**Mean (±SD)**
Level of Grade -0	62	1.259 (±0.048)
Level of Grade - 1	59	1.766 (±0.132)
Level of Grade -2	41	2.543 (±0.578)
Level of Grade – 3	36	3.326 (±0.327)

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Level of Grade – 4	28	5.154 (±0.639)

"Table 3 : Correlation between Serum Creatinine with Ultrasonographical parameters like Parenchymal Thickness, Longitudinal Size, Cortical Thickness, and Echogenicity grade"

Variables	**Serum creatinine**		**Echogenicity Grade**	
	r	***p***	***r***	***p***
Serum creatinine	1.0	0.000	0.947**	0.0001
Parenchymal Thickness	0.421**	0.0005	0.341**	0.005
Longitudinal Length	-0.509**	0.0005	-0.529**	0.0005
Cortical Thickness	-0.761**	0.0005	-0.695*	0.0005
Echogenicity Grade	0.947**	0.0001	1.0	0.000

Discussion:

The morphological assessment of the kidney is identified as a simple as well important tool for the diagnosis and treatment of CKD. Renal length is a simple parameter, that can be easily measured by ultrasonography, and it was observed that it diminishes in advanced CKD. Chronic kidney disease refers to kidney damage that occurs over time as a result of anatomical or functional abnormalities of the renal. The kidneys stop functioning as the damage progresses, whether or not the GFR drops, and this is indicated by clinical abnormalities, changes in renal damage indicators, or anomalies in imaging studies [18,19].

This current study uses serum creatinine to estimate GFR and measure the functional capacity of the renal tissue in CKD. The best imaging modality for measuring renal measures and echogenicity in real-time is sonography, which is widely accessible and reasonably priced.

The endogenous serum creatinine level can be used to determine the GFR and disease stage [21]. While the mean of the longitudinal length in our study was 9.86 cm. The normal length of the kidney in adults is 10-14 cm long in males and 9-13 cm long in females. A study carried out by O'Neill et al suggested that the higher limit of the normal renal length is 12 cm [20]. In another study, Fiorini and Barozzi reported that kidney length less than 8 cm is unquestionably diminished which might be associated with chronic renal failure [22]. The length of the kidney has historically been used as a substitute indicator of renal function since it declines with deteriorating renal function. Therefore, assessment of the length of kidneys can be considered as one of the prominent markers for the disease progression.

In our investigations, a significant association was observed between a biochemical parameter of RFT assessment and the USG parameter. The circulatory levels of creatinine were significantly correlated with the degree of echogenicity (p=0.0001). In a study, carried out by Siddappa et al., observed a close correlation between the grade of echogenicity and serum Creatinine. A significant association between the grade of echogenicity and serum Creatinine was also reported by Ibinaiye et al. and Singh A et al. [24].

A study published by Siddappa et al. reported close observations to our study, in their investigations. In this study, they have reported a statistically significant positive connection (p = 0.009) between the echogenicity grading and parenchymal thickness of kidneys by ultrasonography [25]. Their study

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reported that the mean parenchymal thickness decreased with increasing echogenicity.

According to this study, the mean of the cortical thickness varied significantly according to the degree of echogenicity. The average cortical thickness in our study was 0.93 cm or 9.3 mm (p=0.0005). Singh et al., reported similar findings and discovered that the mean cortical thickness was one of the important markers for assessment of renal dysfunction. Their study identified the average thickness as 0.85 cm or 8.5 mm [23, 24]. The mean cortical thickness decreased with increasing echogenicity.

The cortical echogenicity of renal tissue increases along with circulatory levels of creatinine. Since changes in renal echogenicity are irreversible, it is possible to grade CKD and also to determine its grade and severity.

Conclusion:

The present study concluded that ultrasonography is one of the effective non-invasive techniques for the diagnosis of CKD. One of its most reliable ultrasonographic parameters closely correlates the circulatory concentration of creatinine with the cortical echogenicity of kidneys by ultrasonography. Further, it has also been observed that the grading of cortical echogenicity plays an important role, as compared to other parameters like longitudinal length, parenchymal thickness, and cortical thickness in patients with CKD. The circulatory concentration of creatinine may vary from day to day, but renal cortical echogenicity is irreversible, and it might be considered a standard parameter for the assessment of the functioning of the kidneys.

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