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Renal Anatomy Unveiled: Exploring the Interplay of Kidney Morphology and Biochemical Markers in a Retrospective Study

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ABSTRACT

Background: The kidneys are important for maintaining hemostasis, they control the balance of water (fluid) concentrationos and long-term waste excretion in response to changes in homeostatic needs. Blood urea nitrogen (BUN), serum creatinine, and other compounds serve as biochemical markers evaluating renal function; however morphological features are also useful parameters reflecting the health of the kidney in particular its size.

Aims And Objectives: To evaluate the relationship of urea/creatinine levels with kidney size in patients undergoing abdominal imaging

Methods

1st January,208 and 31 Decamber,2013 Saidu Group Of Teaching Hospitals Swat.We recorded clinical data, including demographic details (age and sex), comorbidities. Activities include measurements of kidney size, biochemical analyses and correlation co-efficients & multivariate regression.

Results: The analysis showed a positive correlation of kidney size (especially volume) with urea/creatinine levels and thus possibly predict implications for assessment of renal function. In the analysis, which had an exploratory value and included 310 patients in a retrospective pathway, there was significant positive association between kidney size (volume) with values of urea ($r = 0.32$; $p < .001$) as well creatinine levels($r=0.28, p<0001$). Increased creatinine and decreased kidney size measurements in diabetes mellitus (DM) and hypertension (HTN) suggested a clinical relevance of renal outcome. They might also emphasize the importance of kidney length for assessing renal health and tailoring patient management strategies.

INTRODUCTION

The kidneys are vital organs that play a central role to homeostasis in the human body being responsible for control of fluid balance, sodium and electrolyte concentrations as well as waste metabolites clearance. Kidney function is typically evaluated by biochemical markers such as BUN and serum creatinine levels, which have a direct relationship to glomerular filtration rate (GFR) that indicates an overall renal functional assessment. Nevertheless, other than biochemical parameters will be possible to discuss morphological aspects of the kidneys - about their size and so on, which can tell at least a little bit more about what is happening in terms of kidney anatomy and physiology. 1, 2Kidney size can also be measured with imaging modalities like ultrasound or CT, which gives an added degree of information about kidney health. Alterations of kidney dimensions may suggest changes in renal blood flow, nephron number or other focal renal pathology. For diagnosis, monitoring and management of different renal diseases it is therefore relevant to study the relationships between kidney size and biochemical markers of renal function as urea or creatinine levels are. 3,4,5In this sense, the relationship between kidney size and urea/creatinine level has been investigated for many years but nevertheless remains an open question. Although an association between kidney size and renal function parameters exists in some studies, others suggest contradicting results or limited correlation. Accordingly, additional work is required to determine the character and importance of renal morphology in relation to biochemical markers used to assess kidney function. 6, 7, 8, 9 Objective: We sought to evaluate the relationship of kidney size with urea/creatinine in our cohort. Incorporating clinical data and imaging findings, we aim to characterize the potential value of kidney size measurements as adjunctive indices for renal function. We sought to determine if the combination of renal morphology and biochemical parameters provide better insight into kidney health, enabling an improved approach for early identification of injury as well as tailored patient management.

MATERIALS AND METHODS

Material and methods This was a retrospective study carried out at Saidu Group of Teaching Hospitals, Swat including 310 patients who had their abdominal imaging (ultrasound, CT or MRI) from January 1st to December the ending day of March2022. 10

Inclusion criteria:

Over a 40-day period, patients with full kidney size measurements and urea/creatinine from the same timepoint were consecutively included.

Exclusion criteria:

Exclusion criteria: history of renal surgery, or incomplete medical records.

Data Collection:

Demographic data (age, gender) and clinical comorbidities (hypertension, diabetes mellitus..etc. were collected from the medical records along with laboratory investigations. Kidney size measurements (in mm for the longest longitudinal and transverse dimensions) were obtained from radiology reports [13] to calculate kidney volume using ellipsoid formula: Volume = length × width × depth, where length is taken as 2d thickness in inches. 11

Biochemical Analysis:

Urea and creatinine measurements were carried-out from blood samples obtained on the day of the imaging procedure. The Modification of Diet in Renal Disease (MDRD) or Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) Equation was used to calculate eGFR.

Statistical Analysis:

Statistical analysesStatistical analyses were performed using the SPSS (for Windows, version 17. Results: Descriptive statistics were used to provide a summary of patient characteristics, kidney size parameters and biochemical profile. Pearson correlation coefficients were used for analyzing the relationship between kidney size (volume) and urea/creatinine levels. Result Multivariate regression analysis after adjustment for age, gender and co-morbidities as potential confounders. 12, 13

Ethical Considerations:

The study was conducted according to the Declaration of Helsinki, and it has been approved by Institutional Review Board/Ethics Committee Saidu Group of Teaching Hospital Swat Research on humans and animals -Informed consent was not applicable for this study that did neither prospective but retrospective, no identifying individual information. 14

RESULTS

A total of 310 patients were included in the study. Patients mean years old, and the standard deviation (SD) of those 58-year olds SD = 12.5 Male and female patients were 55% males and 45%.Number and % of patients diagnosed with hypertension (n = 124;40%) The number of patients with diabetes mellitus was (n = 93, 30%), and percentage discloses the proportion to other diseases.

Table- 1: Overview of the patient characteristics

Characteristic	Total Patients	Mean (SD)	Male (%)	Female (%)	Hypertension (n)	Diabetes Mellitus (n)
Total Patients	310	-	-	-	-	-
Age (years)	-	58 (12.5)	-	-	-	-
Gender	-	-	55	45	-	-
Hypertension	-	-	-	-	124 (40%)	-
Diabetes Mellitus	-	-	-	-	-	93 (30%)

Table- 2: Kidney Size Measurements and Comparison with Diabetes Mellitus and Hypertension

Measurement	Mean Value (± SD) for DM	Mean Value (± SD) for No DM	Mean Value (± SD) for HTN	Mean Value (± SD) for No HTN
Longitudinal Dimension (cm)	11.7 (± 1.8)	11.8 (± 1.7)	11.5 (± 1.9)	11.9 (± 1.6)
Transverse Dimension (cm)	6.5 (± 1.2)	6.7 (± 1.1)	6.4 (± 1.3)	6.8 (± 1.0)
Kidney Volume (cm^3)	150 (± 25)	152 (± 22)	148 (± 28)	155 (± 20)

Table-3: Biochemical Markers and Kidney Size Measurements with Relationships to Diabetes and Hypertension

Parameter	Mean Value (± SD)	Range	Relationship with Diabetes Mellitus (DM)	Relationship with Hypertension (HTN)
Urea Level (mg/dL)	28 ± 8.2	12-60	Elevated in DM	-
Creatinine Level (mg/dL)	1.2 ± 0.4	0.6-2.4	Elevated in DM, HTN	-
eGFR ($mL/min/1.73m^2$)	75 ± 15	-	Decreased in DM, HTN	-
Longitudinal Dimension (cm)	11.7 ± 1.8	-	-	Decreased in HTN
Transverse Dimension (cm)	6.5 ± 1.2	-	-	Decreased in HTN
Kidney Volume (cm^3)	150 ± 25	-	Decreased in DM, HTN	Decreased in HTN

Table-4: correlation between kidney size (volume), urea levels and creatinine levels

Parameter	Correlation Coefficient (r)	p-value
Kidney Size (Volume)	0.32 (Urea), 0.28 (Creatinine)	<0.001

DISCUSSION

There is insufficient available evidence to determine the association between kidney size and patients with CKD and those without (eGFR<60) based on a small pool of patients in this retrospective database study; however, findings provide insights into associations with biochemical markers for renal function notably serum urea or creatinine levels. This relationship is important to study for improving our ability to assess renal health and tailor management strategies.We found a strong positive correlation between kidney size, mostly volume and urea/creatinine. This implies that large kidneys may also imply elevated urea and creatinine levels, raising the question of its possible consequences on renal function. The values were consistent with a prior finding by other researchers, that changes in renal morphology such as size may be indicative of abnormality and/or dysfunction. 15,16 In multivariate regression analysis, controlling for age, sex and comorbidities kidney size independently predicted the levels of urea (p=0.033) and creatinine(sec dialogRef.). This underscores the potential clinical use of kidney size measurements as a supplemental indicator for evaluating renal function beyond conventional serum biomarkers.Comorbidities such as DM and HTN influence this parameter, which our study also assessed for kidney size and biochemical markers. One the other hand, common measurements of kidney size showed somewhat lower mean values among those with DM than for non-diabetics; one could even argue that these differences are not clinically meaningful In contrast, patients with DM and HTN had higher creatinine levels and lower eGFR values reflecting a reduction of kidney function in both groups. To make it even more interesting, the participants with HTN had lower measurements of kidney size when compared to those without hypertension, which suggests a relationship between hypertension and structural changes in kidneys. This confirms previous literature that high blood pressure can lead to renal damage and remodeling, thus changes in kidney morphology. 17, 18The complexity of the relationship between kidney morphology and biochemical markers of renal function is also highlighted by our results. While kidney size measurements could add useful ancillary markers, more research is required to determine the pathophysiological basis of these associations and their clinical relevance. Validation in longitudinal studies and larger cohorts is needed to confirm our findings, support the utility of kidney size assessment across various clinical settings, and further inform on renal health and disease progression.

CONCLUSION

Conclusions: Our historical study gives us insight into the relationship of renal size with biochemical makers if kidney function in a population. There was a significant positive correlation between kidney size (especially the renal parenchyma volume) and urea/creatinine values, which might have some implications in the evaluation of proper renal function. Therefore, this suggests that measurements of kidney size could be complimentary markers to biochemical parameters in the assessment of renal health.In addition, our study also emphasized the effect of comorbidities like diabetes mellitus (DM), and hypertension (HTN) on kidney size as well biochemical markers. DM and HTN were linked to kidney size measurements abnormalities, in addition of altered renal function; however the underlying mechanisms had not yet been investigated.These results together emphasize that the assessment of renal function should not only account for morphological parameters but also biochemical indices. Longitudinal studies in larger cohorts are needed to confirm our finding as well as elucidate clinical implications of kidney size evaluation among different populations.Our study contributes to a pooled effort on the improvement of renal health outcomes, highlighting that adjusting morphological features is essential in order to refine patient management strategies across clinical practice.

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