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ORIGINAL ARTICLE

Association of renal function by measuring glomerular filtration rate with renal dimensions in Pakistan: A Tertiary Care Center Study

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ABSTRACT

Objective: In kidney morphological changes in size are manifested by renal pathologies and are of great significance in clinical assessment of patients with kidney diseases. Therefore of the objective of this study is to report normative data of renal dimension and its correlation with renal function.

Design of the study: It was a cross sectional study

Place of study: This study was conducted in a tertiary care hospital, Dr. Ziauddin University Hospital, Karachi from January, 2017 to June, 2017.

Material and Methods: Total 250 individuals were included in the study. The participants were recruited through convenient sampling, from Ziauddin University. Study participants were 21 to 60 years of age, who were referred to Radiology department for abdominal contrast CT.All kidney dimensions including kidney length, kidney width and anteroposterior diameter were taken by using 16-slice Multidector computed tomography MDCT scanner. Serum creatinine of study participants was used to calculate eGFR by Modification of Diet in Renal Disease formula. Data was analyzed by using SPSS version 20, Pearson's correlation was applied to find association between renal measurements and calculated eGFR. Results were reported with confidence level at 95% and P-value ≤ 0.05 was considered to be significant.

Results: Renal measurements of study participants were renal length (Right:10.81±0.71, left:11.12±0.73) and renal volume (right: 118.80 ±17.98 cm^3, left: 126.00 ±18.36 cm^3). Mean glomerular filtration rate was found to be 112.8 ± 11.20 ml/min/1.73 m^2.

Conclusion: This study concludes that renal length and renal volume are best correlated with glomerular filtration rate by showing a strong significant positive correlation with estimated glomerular filtration rate in study

Key words: Computed tomography, renal length, glomerular filtration rate, serum creatinine

INTRODUCTION

From total cardiac output, approximately 20% to 25% (1.0 to 1.1 L /min.) goes in kidneys. Blood enters glomerular tufts through the afferent arteriole and exits out through efferent arteriole. Glomerular filtration rate (GFR) is defined as flow of the plasma from the glomerulus into Bowman's space over a specified period and chief measure of kidney function.(1)

Glomerular filtration rate also estimates how much blood passes through the glomeruli each minute. It is the actual rate of filtration of fluid filtered through the glomerular capillaries into renal tubule per unit time.(2,3)National kidney foundation recent guidelines recommends glomerular filtration rate as the best test to measure the level of kidney function to determine the stage of kidney disease.(4) Assessment of kidney function by evaluation of glomerular filtration rate (GFR) is essential for kidney function in medical practice.(5)Measured GFR remains the reference standard, however in the past 20 years estimated glomerular filtration rate (eGFR) is recommended by clinical practice guidelines, regulatory agencies and public health agencies for the evaluation of GFR.(6)In healthy people, normal eGFR is 90 ml /min/1.73 m^2 or higher. (7)

Literature revealed a positive correlation between kidney dimension and estimated glomerular filtration rate suggesting kidney dimensions to be reflective of functional renal capacity.(8)Many other studies also emphasized kidney volume as an indicator of renal function and a true predictor of kidney mass and surviving nephron.(9,10)Guidelines from National-Kidney-Foundation guidelines recommends, Modification of Diet in Renal Disease (MDRD) formula to be used for calculation of eGFR in adults.(11) This formula is validated and used widely in Asian population.(8,12)

In renal dimensions, renal volume has been postulated to be the reliable indicator of nephron mass and glomerular number. In chronic kidney disease renal volume was appraised as a useful marker for assessment of renal function.(13, 14)

METHODOLOGY

The study was done in a tertiary care hospital, Dr. Ziauddin University Hospital, Karachi. This was a cross sectional study, carried out after taking approval from ethics review committee of Ziauddin University. Total 250 individuals were included. Study participants were recruited through convenient sampling, from Ziauddin University Hospital, Clifton, and Karachi. Calculation of sample size was done by using WHO sample size calculator with prevalence at 21 %.(15)Confidence interval at 95%.All study participants were of age 20 to 60 years, who were referred for abdominal contrast CT examination for various indications such as liver lesions, pancreatic lesions, intestinal obstruction and gastro intestinal diseases. Those study participants having renal transplant, renal surgery, renal tumor, renal stone, and hypersensitivity to contrast agent, hypertension, diabetes Mellitus, vasculitis, congenital renal anomaly and pregnancy were excluded from study. Also those participants having eGFR of ≤ 60 ml/min/1.73 m^2 were also excluded from the study. Written informed consent was taken and questionnaire having demographic profile and complete historyfrom study participants were recorded.

All individuals were divided into four age groups as; Group 1 includes individuals 21to30 years, Group 2 from 31to 40 years, Group 3 from 41to 50 years and Group 4 from 51to 60 years. Serum creatinine of study participants was used to calculate eGFR by Modification of Diet in Renal Disease formula (MDRD):

"GFR (mL/min/1.73 m2) = $186 \times (Cr)^{-1.154} \times (Age)^{-0.203} \times$ (0.742 if female)", where Cr is Serum Creatinine, 0.724 is the correction factor for female.(11)

All kidney dimensions including kidney length, kidney width and anteroposterior diameter were taken by using 16-slice Multidector computed tomography (MDCT) scanner, 16 slicer Alexion, Japan as shown in Figure 1 and Figure 2. The scanned area was extended from diaphragm to iliac crest. A workstation (Toshiba Medical Systems) was used for image processing, to post-process the MDCT volumetric data sets. Three dimensional

reconstruction of images in different planes and projections is done by using a software. Volume of kidney was calculated by the Ellipsoid formula.[10,16]

Kidney Volume (cm^3) = length (cm) × width (cm) × thickness (cm) $\times\frac{\pi}{6}$.

The data was analyzed on SPSS version 20.Mean and Standard Deviation were calculated for quantitative variables (age, renal length, renal width, renal anteroposterior thickness, renal volume, e GFR. Bivariate analysis (Pearson's correlation) was applied to find association between renal measurements and calculated eGFR. Confidence interval was at 95% and P-value of≤ 0.05 was significant.

RESULTS

In this study, total participants were 250 (500 kidneys) included. Overall characteristics of study participants are shown in Table 1. Renal measurements measured are shown in Table 2.

Table 1: Total study participants

Variables	Total number % (n)	Age (years) Mean ± SD
Total participants	100% (250)	43.9 ± 11.8
Males	52 % (129)	43.5 ± 11.0
Females	48 % (121)	44.3 ± 12.6

n= Total number, SD = standard deviation.

Table 2: Renal measurements of study participants

Renal dimensions Total number n=250	Right Kidney Mean ± SD	Left Kidney Mean ± SD
Renal Length (cm)	10.81±0.71	11.12±0.73
Renal Width(cm)	4.77±0.23	4.84±0.23
Renal Anteroposterior thickness (cm)	4.36± 0.21	4.44 ±0.29
Renal Volume (cm^3)	118.80 ±17.98	126.00 ±18.36

n= Total number, SD = standard deviation.

The mean eGFR of study participants was found to be 112.8 ± 11.20 ml/min/1.73 m^2. By using Pearson's correlation, renal length and renal volume are best correlated with eGFR and a strong positive significant correlation was found between right renal volume with eGFR (R = 0.753, p= 0.001) and between left renal volume with eGFR (r = 0.747, p= 0.001) Figures 1& 2. However, right renal width (width, R=0.669, p=0.001)and AP thickness(width, R=0.690, p=0.001) showed moderate positive correlation with eGFR. Left kidney renal width (width, R=0.662, p=0.001)and AP thickness(width, R=0.652, p=0.001) also showed moderate positive correlation with eGFR.

Figure 1: Scatter plot showing a significant strong positive correlation between right renal volume and e GFR (r = 0.753, p = 0.001)

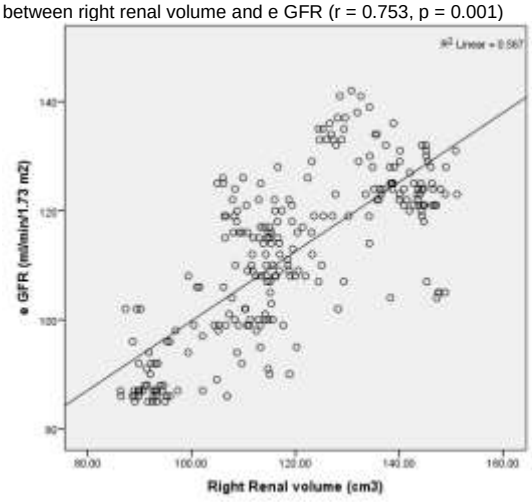
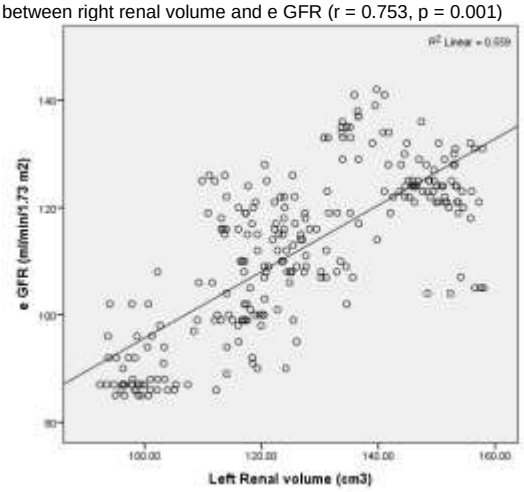


Figure 2: Scatter plot showing a significant strong positive correlation between right renal volume and e GFR (r = 0.753, p = 0.001)



DISCUSSION

In recent past years, prevalence and absolute burden of kidney disease increases.[17]In present study, study participants were of 21 to 60 years of age. Mean age of participants was 43.9 ± 11.8 years. Kidney measurements found in our study including renal length, width and anterior posterior thickness was more on left side when compared with right side.(Table 1&2) This is mainly due to liver located on right side and it is larger than spleen, which means that the right kidney has less space to grow in size.[18] Our results are in agreement to a study conducted by Mesfin etal. In which they reported renal volume in comparison to single renal measurements as renal length, width and thickness a good predictor of renal size and renal function.[19] Results of this study are also comparable to study conducted by Su HA etal, they also reported renal dimensions of left kidney are significantly more as compared to right kidney.[20]Glomerular filtration rate is an important marker for renal function. [21]

Estimated GFR less than 60 ml/min/1.73 m^2, is a main risk factor for ESRD. In our study mean eGFR of all study participants was 112.8 ± 11.20 ml/min/1.73 m^2.When renal dimensions are correlated with e GFR. Best strongly positive significant correlation was found with renal length and renal volume on both sides.(figure 1&2) Signifying that among all renal measurements, renal length and renal volume is a strong predictor of renal functioning capacity and functional nephron count. As mean renal volume increases eGFR increases and as mean renal volume decreases eGFR declines Moreover, renal volume can be used as basis for clinical decision about kidney functioning.[22]Our finding is comparable to study reported mean eGFR 119 ± 34ml/min/1.73m^2. Moreover, they also found a strong positive significant correlation of renal length rather than renal volume with eGFR.[23] Perhaps as study used sonographic renal measurements, that can be affected by many factors. Previous study conducted on young Korean population reported a positive correlation between kidney volume and e GFR and concluded that kidney volume as compared to kidney length was a better predictor of kidney function. This is explained by the fact that the fact that as compared to a single renal dimensions like length, width or thickness, renal volume is a three dimensional value of kidney size.[24]

To the greatest of our knowledge and review of literature, very few studies conducted to determine the normative data of renal dimensions and correlating this with functional marker of kidney as glomerular filtration rate. To the best of our knowledge, this was the first study which provides baseline reference range of dimensions of kidney including renal volume in adults by using MDCT scan and help to assess renal functioning by considering renal length and renal size**.**

CONCLUSION

This study concluded that renal length and renal volume showed a strong significant positive correlation with estimated glomerular filtration rate. Renal width and anteroposterior thickness showed a moderate positive significant correlation.

Conflict of interest: None

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